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THE MINERALOGY OF PENNSYLVANIA

BY

SAMUEL G. GORDON

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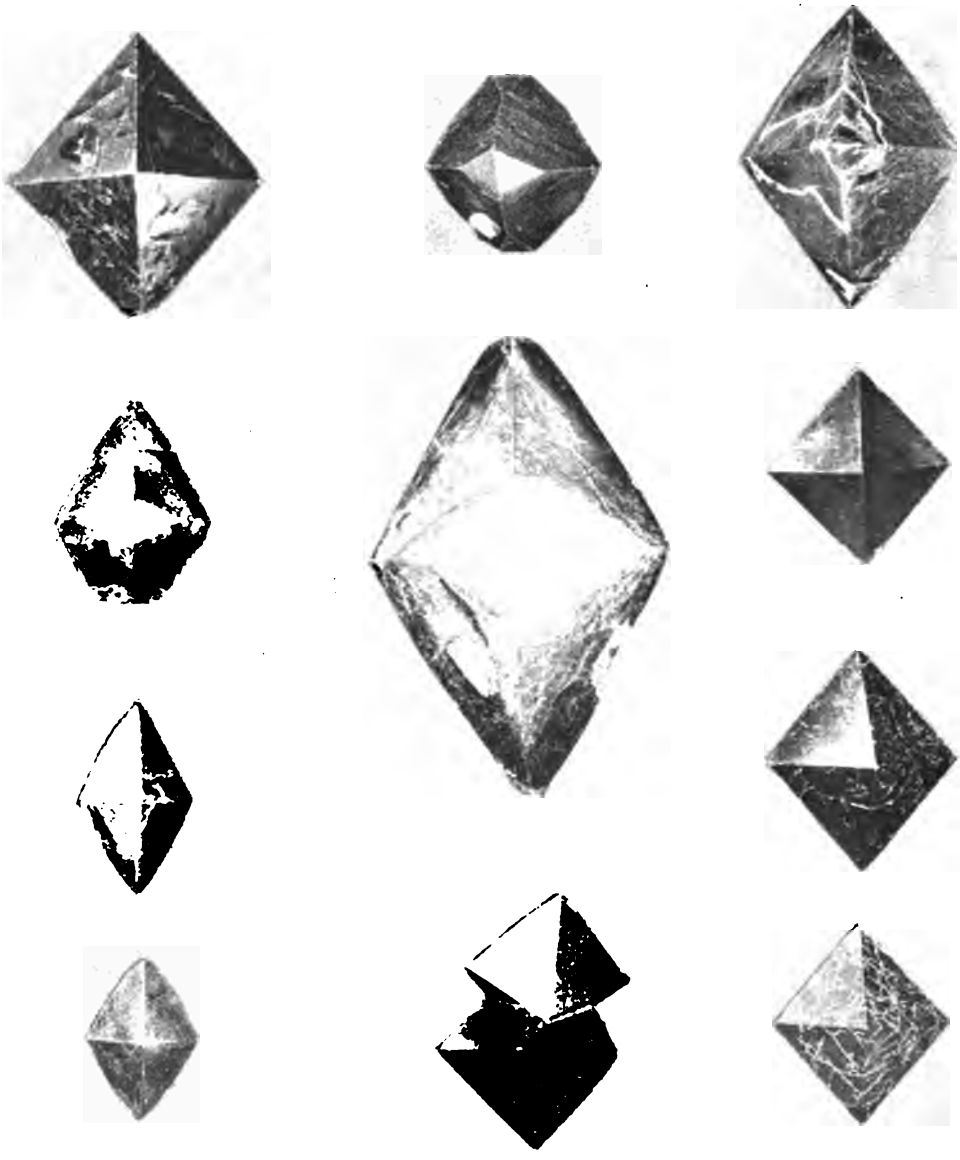
1936



Abnormal pyrite crystals, French Creek mines, Chester County, Pennsylvania. Natural size. The second and third crystals in the left hand row are two of Penfield's types. Courtesy of George Vaux, Jr.

Special Publication No. 1
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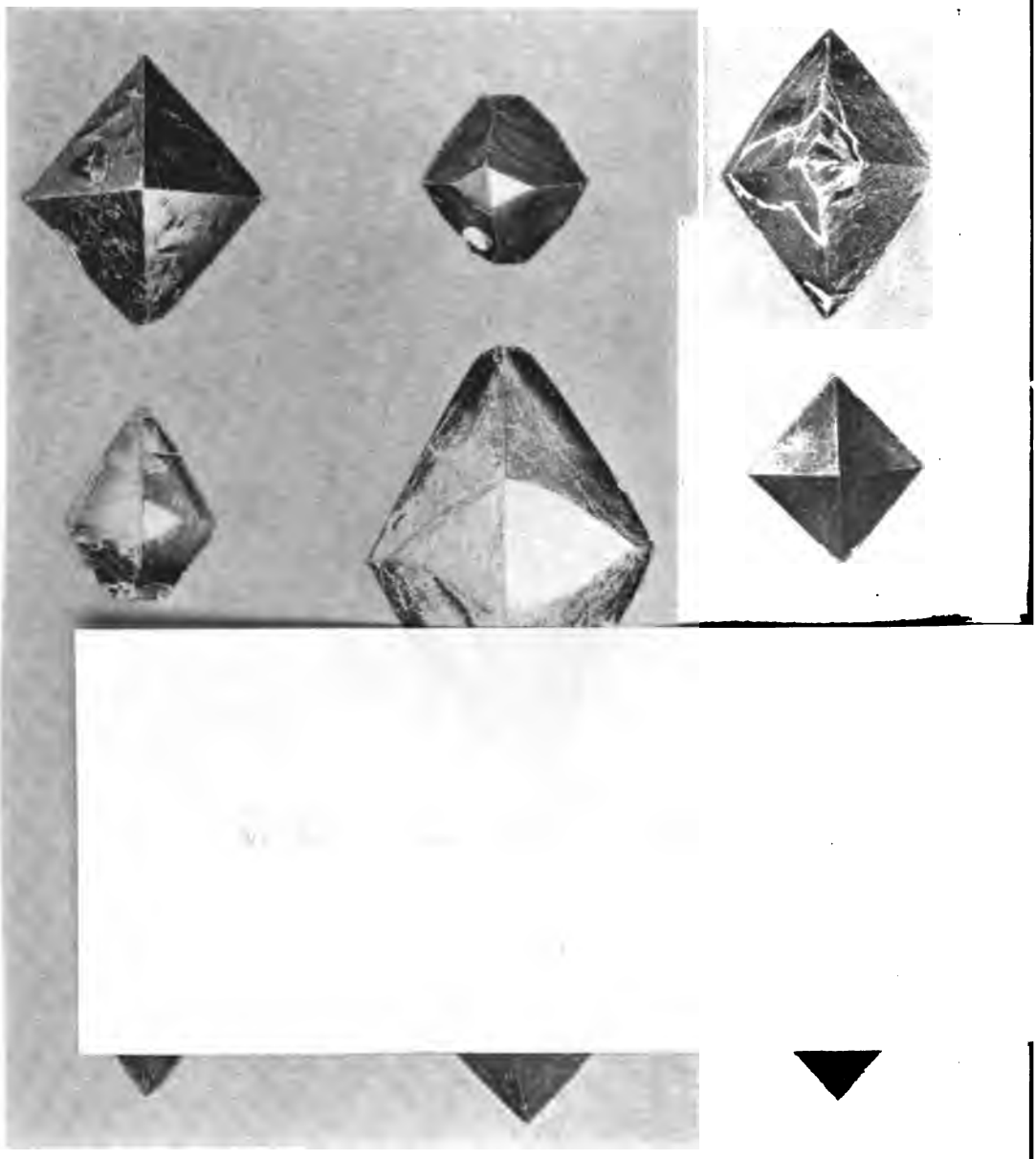
ERRATA

Page 6, lines 18 and 22: *SAMPSON* should read *SANSOM*.

Philadelphia
1922



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CONTENTS

		PAGE
I.	Introduction	5
II.	Origin and occurrence of minerals	11
III.	General geology of Pennsylvania	23
IV.	Descriptive mineralogy of Pennsylvania	34
V.	Mineral localities of Pennsylvania	150
VI.	Bibliography	240
Index		i-iv

I

INTRODUCTION

Historical Outline

The development of mineralogy in Pennsylvania began while the science was yet in its youth. Its inception coincided with the great activity in Europe following upon the interesting discoveries of Priestley and Lavoisier, of Klaproth and Berzelius, and of Abbe Haüy. Great enthusiasm was aroused, resulting in a pilgrimage to the laboratory of Abbe Haüy, in the École des Mines, of several residents of Pennsylvania, notably Adam Seybert, Gerard Troost (a Hollander by birth), and later, Lardner Vanuxem, and William Keating, who may be regarded as the first scientific mineralogists of America.

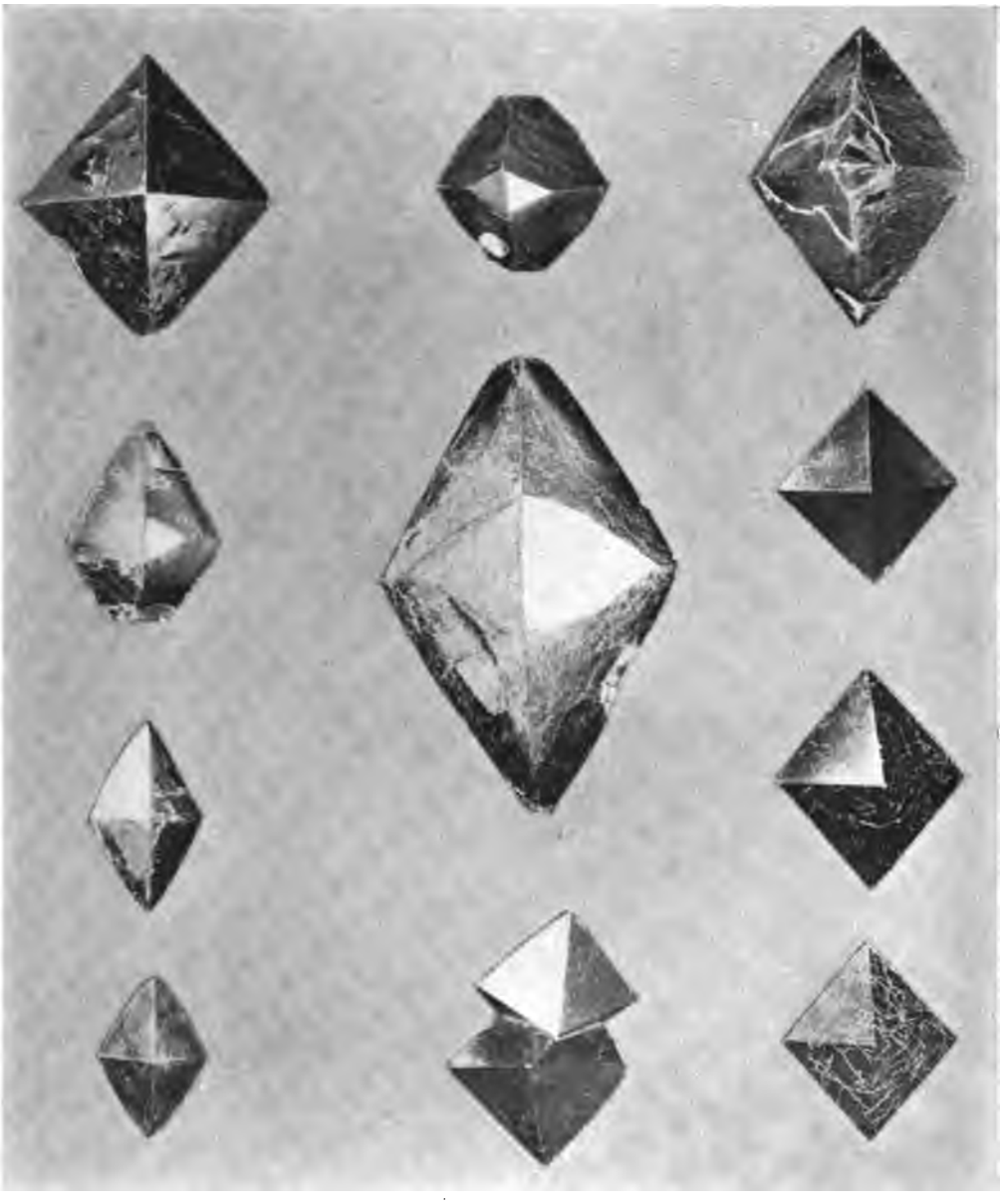
On his return to Philadelphia, Adam Seybert brought with him a fine collection of minerals. It was extremely difficult at this time to get even such common minerals as quartz, hornblende, and feldspar determined, and it is interesting to note that in 1803, Benjamin Silliman, the founder of the *American Journal of Science*, journeyed to Philadelphia with the whole collection of Yale College, "a half bushel of unlabeled stones in a small box," to have them named by Seybert.

Somewhat previous to this (1792) the Chemical Society of Philadelphia had been organized with the avowed purpose of acquiring information regarding the minerals of the United States. The society existed for seventeen years, and was succeeded in 1811 by the Columbian Chemical Society, in whose single volume of memoirs appeared an analysis of malachite from "Perkioming" by Thomas D. Mitchell.

In 1812, the Academy of Natural Sciences of Philadelphia was organized with Dr. Gerard Troost as president. Mineralogically the first accession consisted of some artificial crystals prepared by Dr. Troost, but on August 15th the Academy acquired by purchase the collection of Adam Seybert, which later formed the subject of a number of lectures by Troost. This collection, the oldest extant in America, is still kept intact in its original cabinet. In April, 1812, the members of the Academy made an excursion to the Perkiomen mines. Their activity is shown by the number of mineralogical and crystallographic papers that appeared in the early issues of the Journal of the Academy.

In 1812, Isaac Lea published "An account of the minerals at present known to exist in the vicinity of Philadelphia." This was followed by more complete lists by Carpenter and Spackman, the results of a vacation trip on horseback into Delaware, Chester, and Lancaster counties. Some time before, however, Adam Seybert had published in 1808 "A catalog of some minerals which are found in different parts of the United States."

The mineral collection of the Academy grew rapidly, large numbers of specimens being presented by its members. In addition, it received the collections of Thomas M'Euen, T. B. Wilson, Samuel Ashmead, George W. Carpenter, W. D.



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other details concerning the title of the paper and place of publication will be found in the bibliography.

ACKNOWLEDGMENTS

In conclusion the writer desires to express his appreciation and thanks to those who kindly aided in giving information regarding Pennsylvania minerals: to Dr. Edgar T. Wherry for much data, and a critical examination of the manuscript; to Mr. George Vaux, Jr., Mr. Frank J. Keeley, and the various members of the Philadelphia Mineralogical Society, notably Mr. Harry W. Trudell, Mr. William Knabe, Mr. Frederick Oldach, Mr. Hugh McKinstry, Mr. Hugh Alexander Ford, Dr. Alfred C. Hawkins, Mr. John Frankenfield, Mr. Frederick Hilbiber, and Mr. John Tallis. The writer is also indebted to Dr. George P. Merrill for an unpublished analysis of asbestus from Aston, Delaware County; to Mr. H. L. Willig for information regarding the minerals of Lancaster County; to Mr. John Pierce and the late Thomas Harvey for data regarding southern Delaware County; and to Mr. Bentley R. Morrison for certain data on northern Chester County.

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While many minerals have a particular mode of occurrence, more characteristic is their grouping into assemblages. The above classification of mineral assemblages has been proposed[4] (Table I).

Mineral assemblages may be divided into two distinct classes: those arising from magmatic phenomena,—the igneous rocks, pegmatites, hydrothermal deposits and fumarolic deposits; and those formed by sedimentary processes,—the sedimentary rocks. The minerals forming the assemblages may be classified as primary, metamorphic, or weathering products.

Magmatic Phenomena

A molten magma may be regarded as a solution of silicates, containing dissolved in it considerable quantities of water and gases, and obeying the physicochemical laws of a solution; the freezing point is lower than that of its constituents and the crystallization of the minerals is dependent on their solubility in the magma more than upon their temperature of fusion.

The phenomena exhibited by molten magmas are exceedingly complex, not the least interesting being those which cause their differentiation into the various igneous rocks.[5]

The magma is composed essentially of silicates, with dissolved H_2O, CO_2, F, Cl, B, S, H, and other volatile substances, to which the term mineralizers or pneumatolytic agents has been applied. The latter term is objectionable, as it is extremely doubtful if these gaseous substances exist as such in the magma or in solutions emanating from it, but are rather dissolved in each.

The products of the solidification of the bulk of any magma are the igneous rocks, composed essentially of anhydrous minerals or those in which a hydroxyl radicle is present, such as hornblende, biotite, muscovite, etc. The disposition of the volatile constituents is dependent on the depth at which the igneous body solidifies. The mineralizers are far more abundant in the acid rocks than in the basic ones, and there may also be a difference in the kind present. In deep seated bodies such as granites, granodiorites, syenites, etc., there is a gradual concentration of the volatile constituents and most of the rare elements in the residual mother liquid; this is forced into contraction fissures in the parent body, or into fractures in the surrounding rocks, forming pegmatite dikes or veins.

At lesser depths fracturing in the crust may permit the heated solutions to pass into fissures, where they may form hydrothermal veins. Quite frequently the

[4] Edgar T. Wherry and Samuel G. Gordon, An arrangement of minerals according to their occurrence: Proc. Acad. Nat. Sci. Phila., 67, 426–457, 1915.

A wealth of data on the subject of the occurrences of minerals will be found in the following works, which give many references:

F. W. Clarke, Data of Geochemistry: U. S. Geol. Surv. Bull. 695, 4th Ed., 1920.

Waldemar Lindgren, Mineral Deposits, 2nd Ed., New York, 1919.

William Harvey Emmons, The enrichment of ore deposits: U. S. Geol. Surv. Bull. 625, 1917.

Amadeus W. Grabau, Principles of salt deposition: New York, 1920.

[5] A full discussion of differentiation will be found in the following works:

N. L. Bowen, Crystallization differentiation in igneous magmas: J. Geol., 27, 393–430, 1919; Deformation of crystallizing magma: J. Geol., 28, 265–267, 1920; Later stages of the evolution of the igneous rocks: J. Geol. Suppl., 23, 1–91, 1915.

Frank F. Grout, Movements in crystallizing magma: J. Geol., 28, 255–264, 1920.

Joseph P. Iddings, Igneous rocks: New York, 1909.

A. Harker, Natural History of igneous rocks: New York, 1909.

R. A. Daly, Igneous rocks and their origin: New York, 1914.

solutions may pass into the rock intruded, forming a hydrothermal deposit, with the development of an interesting series of contact minerals.

Extrusions of lava upon the surface permit the rapid escape of the volatile constituents, which may form a series of fumarolic minerals.

Cooke[6] has suggested that the emission of solutions from a cooling magma is constant, their escape being governed by accidental movements affording channels of flow; and further, that the composition of the solutions depends on the stage reached in the crystallization or cooling of the igneous body at the time of escape.

In many of the basic or ultrabasic rocks, segregations of magnetite, ilmenite, chromite, pyrrhotite, and chalcopyrite occur. These have been regarded in the past by some as early accumulations of the usual accessory minerals through gravitative settling at the bottom of the igneous body, and by others as due to immiscibility. Recent studies by Tolman and Rogers,[7] however, indicate that these magmatic ores have been formed at a late magmatic stage as the result of mineralizers, the ore-minerals in many cases replacing the silicates.

Sedimentary Phenomena

Subjected to the action of water, wind, and ice, the land masses are eroded and worn down; the disintegrated particles are rapidly removed by running water, which carries also much dissolved material. This disintegration and decomposition is the beginning of a series of events resulting in the differentiation of the materials into mineral assemblages varying widely in make-up: the sedimentary rocks. Briefly, they may be formed mechanically by moving water, ice or the wind; chemically; or organically. In some cases certain rocks may be produced in several ways: thus, siliceous sediments are formed by mechanical agencies (sandstone, etc.), chemically (some flints), or organically (some flints and diatomaceous deposits). As the products are in most cases identical, they are most simply classified chemically, if sight is not lost of their origin. We have then, six groups of sediments: A. Siliceous and argillaceous; B. Calcareous and magnesian; C. Ferruginous; D. Saline; E. Phosphatic; and F. Carbonaceous.

Metamorphism and Weathering

Under the action of heat, pressure, and magmatic or meteoric solutions, striking changes occur in the minerals of the igneous and sedimentary rocks, with the development of new assemblages. Much ambiguity exists in the literature regarding the processes and their results, as the changes are in many cases complex.

The following are the chief agents of metamorphism: heat—due to intrusives or to deep burial in the crust; pressure—static pressure developed by burial to great depth, or dynamic pressure due to earth movements, tangential thrust and the like; and solutions—meteoric solutions of surface origin, or magmatic solutions emanating from cooling igneous masses. One or more of these may operate at a given time, but the general types of metamorphism may be described as follows.

Weathering involves the changes produced by atmospheric agencies; running water, ice, the wind, also organic life, etc., from the surface to the level of ground

[6] H. C. Cooke, Gabbros of East Sooke and Rock Point: Canada Dept. Mines Museum Bull. 30, 1919, p. 48.

[7] C. F. Tolman, Jr., and Austin F. Rogers, A study of the magmatic sulfid ores: Leland Stanford Junior University Publ., 1916.

water. The rocks are disintegrated and decomposed, the more soluble constituents are leached out, and only a few minerals stable under surface conditions persist. The chief reactions are oxidation, hydration, and carbonation, and solution.

Hydrometamorphism.—Meteoric solutions arising at the surface tend to circulate to shallow depths through joints, fractures, and solution cavities. Much of the material dissolved in the weathering processes may be deposited here. This type of metamorphism is perhaps limited to kaolinization, the cementation of sediments, the formation of lead, zinc, celestite, and barite deposits in some limestones, and the secondary enrichment of certain sulfide deposits. It is at times difficult to consider weathering and hydrometamorphism separately as they tend to operate together, as in kaolinization. An interesting case is that of the kaolin deposits occurring in the limestone of southern Chester County, Pa. The weathering and erosion of the limestone has given rise to solutions rich in CO_2, which vigorously attacked the pegmatites, with leaching of the alkalies and the production of kaolin.

Hydrothermal metamorphism.—Greater activity, however, is shown by hydrothermal solutions emanating from cooling igneous bodies, which may effect the serpentinization or chloritization of the basic or ultrabasic igneous rocks, the kaolinization of the more acid rocks, and the formation of zeolite veins in gabbros, diabases, and basalts.

Contact metamorphism is produced by the action of igneous masses upon the rocks invaded. The agents are heat produced by the igneous mass, and magmatic solutions which may pass into the intruded rock. The chief factors affecting the degree and type of metamorphism are: character and composition of igneous rock; character and composition of the invaded rock; amount and character of mineralizers, and the ease with which they pass into the invaded rock; and the depth at which the intrusion occurs. Granites, etc., are perhaps influenced least, limestones, shales, etc., most. The changes may be great, but even in some limestones the effect of a diabase dike may be practically *nil*, where under other circumstances great changes have occurred.

Dynamo-metamorphism.—It is extremely doubtful if static heat and pressure are effective agents in metamorphism. Many sediments have been buried to great depths and suffered little change. The question arises as to the relative importance of the agents: heat, static and dynamic pressure, and magmatic solutions, in the production of the familiar crystalline schists and gneisses. Dynamic pressure or stress at great temperatures would perhaps have only the effect of shearing, granulation, and gliding, or recrystallization in limestones. It seems, therefore, that magmatic solutions are necessary, in addition to stress, for the production of the schists and gneisses, where much recrystallization occurs, with the production of new minerals. Evidence of this lies in the universal presence of intrusive masses in the schists and gneisses. A very interesting example is presented by the Ordovician phyllites exposed along the Susquehanna River from Bald Friar, Maryland, northward into Pennsylvania. In the more southern exposures, the phyllites are thoroughly injected with pegmatites which are lacking towards the north near Peach Bottom, Penna. The effect of the dynamic movement and the intrusives was the production of a contorted and recrystallized phyllite in the southern exposures; whereas five miles further north the dynamic movement, in the absence of the pegmatites, caused the shearing of the same formation into a slate.

TABLE II

CLASSIFICATION OF THE IGNEOUS ROCKS

			SILICIC						ALKALIC (RARE)					CALCIC		MAGNESIC	
			Characterized by Quartz and Feldspar			Characterized by Feldspar			Characterized by Feldspar, Nephelite, Leucite			Characterized by Nephelite, Leucite		Characterized by Feldspar and Pyroxene		Characterized by Pyroxene and Olivine	
			Chief Type of Feldspar			Chief Type of Feldspar			Chief Type of Feldspar								
			Orthoclase	Orthoclase and Plagioclase	Plagioclase	Orthoclase	Orthoclase and Plagioclase	Plagioclase	Orthoclase	Albite, Oligoclase, Andesine	Andesine, Labradorite	Little Fe-Mg minerals	Much Fe-Mg minerals	Plagioclase (Ab_1 An_1-An) / Pyroxene		Pyroxene	
			Mica, Amphibole, Pyroxene			Mica, Amphibole, Pyroxene			Mica, Amphibole, Pyroxene			Pyroxene			Contain Olivine		Olivine
Chiefly Hypabyssal	Plutonic	Batholiths Laccoliths Dikes	Granite	Granodiorite	Tonalite (Quartz diorite)	Syenite	Monzonite	Diorite	Nepheline Syenite	Teschenite	Essexite Theralite	Urtite Sussexite	Ijolite Nepheline	Gabbro Diabase	Olivine Gabbro Olivine Diabase	Pyroxenite	Peridotite
		Granitoid															
	Laccoliths Dikes Sills	Porphyritic with groundmass	Representatives of the above rocks with large phenocrysts in a holocrystalline groundmass are named by suffixing "porphyry" to the name in each case. Representatives of the rocks below with abundant phenocrysts in a glassy groundmass are named by suffixing "porphyry" to the name in each case.														
Chiefly Volcanic	Surface Flows	Cellular, Glassy, few phenocrysts	Rhyolite	Rhyodacite	Dacite	Trachyte	Latite	Andesite	Phonolite	Basanite	Tephrite		Monchiquite	Auganite (basalt)	Olivine basalt	Augitite	Limburgite Picrite
		Glassy	Acid Glasses											Basic Glasses			
			Obsidian, Perlite, Pitchstone, Pumice											Scoria, Tachylite			
	Beds Strata Necks	Fragmental	Fragmental representatives of the above rocks are named by suffixing "tuffs" or "breccias" to the name in each case.														

After Rosenbusch, Kemp, and Iddings

IGNEOUS ROCKS

The mineralogy of the igneous rocks is rather simple, and forms the chief method of classifying them (Table II). They may be grouped into four divisions on the basis of mineralogical dissimilarity: the Silicic, Alkalic, Calcic, and Magnesic; these names however, only indicate the prominence of the respective constituents, and do not have a strict quantitative significance. Magmatic deposits may occur in the Calcic and Magnesic rocks, and it is sometimes convenient to consider the minerals of these deposits separately.

SILICIC IGNEOUS ROCKS

PRIMARY MINERALS:

Silica: quartz, *Trisilicates, feldspars:* orthoclase, microcline, albite, oligoclase; *Metasilicates, pyroxenes:* augite; *amphiboles:* hornblende; *Orthosilicates, micas:* muscovite, biotite; *rare earth silicates:* zircon, titanite; *Fluo-phosphate:* apatite; *Oxides:* magnetite, ilmenite.

DYNAMIC-METAMORPHS: (in addition to recrystallization of the above)

Metasilicates, amphiboles: hornblende; *Orthosilicates, garnets:* almandite; *hydroxy-:* zoisite, epidote, muscovite, chlorite.

HYDROTHERMAL METAMORPHS:

Silica: quartz, chalcedony, opal; *Orthosilicates, hydroxy-:* epidote, muscovite, sericite; *Phosphate, hydroxy-:* turquois; *Sulfates, hydroxy-:* alunite, jarosite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Silica: chalcedony, opal; *Silicates, hydrous:* vermiculite, kaolinite, chloropal, allophane; *Hydrous oxides:* limonite, wad.

ALKALIC IGNEOUS ROCKS

PRIMARY MINERALS:

Trisilicates, feldspars: orthoclase, microcline, albite, oligoclase, andesine; *Metasilicates:* leucite; *Orthosilicates:* nephelite, cancrinite, sodalite, hauynite, noselite; *Metasilicates, pyroxenes:* acmite, aegirite; *amphiboles:* hornblende, arfvedsonite, riebeckite; *Orthosilicates, micas:* biotite; *rare-earth:* zircon; *Phosphate:* apatite; *Oxides:* magnetite, ilmenite.

HYDROTHERMAL METAMORPHS:

Metasilicates, hydrous: analcite, natrolite, thomsonite, hydronephelite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Silica: chalcedony, opal; *Orthosilicates, hydroxy-:* kaolinite, vermiculite; *Hydroxide:* gibbsite; *Hydrous oxides:* limonite, bauxite.

The alkalic igneous rocks are exceedingly rare. No rocks of this type have been found in Pennsylvania.

CALCIC IGNEOUS ROCKS

PRIMARY MINERALS:

Trisilicates, feldspars: andesine, labradorite, bytownite, anorthite; *Metasilicates, pyroxenes:* enstatite, hypersthene, diopside, augite; *Orthosilicates:* olivine; *micas:* biotite; *Titano-silicate:* titanite; *Phosphate:* apatite; *Oxides:* magnetite, ilmenite, rutile. *Sulfides:* pyrite, chalcopyrite, pyrrhotite, pentlandite; *Element:* iron.

DYNAMIC-METAMORPHS:

Metasilicates, amphiboles: hornblende; *Orthosilicates:* wernerite; *hydroxy-:* epidote, zoisite, chlorite.

HYDROTHERMAL METAMORPHS:

Orthosilicates, hydroxy-: epidote, chlorite; *boro-:* datolite; *hydrous:* thomsonite, prehnite; *Metasilicates, hydroxy-:* pectolite; *hydrous:* analcite, apophyllite, heulandite, stilbite, laumontite, chabazite, gmelinite, natrolite, mesolite, scolecite; *Carbonates:* calcite; *Silica:* quartz, chalcedony; *Elements:* copper, silver.

WEATHERING PRODUCTS:

Silica: chalcedony, opal; *Hydrous orthosilicate:* kaolinite; *Hydrous oxide:* limonite.

Magmatic deposits of pyrrhotite, pentlandite, magnetite, and ilmenite; and hydrothermal concentrations of copper and silver are of great economic importance. Examples in Pennsylvania are the nickeliferous pyrrhotite deposit of Gap, Lancaster County, and the lean copper deposits in the Precambrian basalts of Franklin and Adams Counties. Zeolites are of common occurrence in the Triassic diabase quarries of Adams, Lancaster, Berks, and Montgomery Counties.

MAGNESIC IGNEOUS ROCKS

PRIMARY MINERALS:

Metasilicates, pyroxenes: enstatite, bronzite, hypersthene, diopside, diallage, augite; *Orthosilicates:* olivine; *Oxides:* magnetite, chromite, spinel; *Sulfides:* pyrrhotite, pentlandite, chalcopyrite; *Elements:* diamond, iron, platinum.

HYDROTHERMAL METAMORPHS:

Metasilicates, amphiboles: anthophyllite, tremolite, actinolite (nephrite, asbestus, smaragdite, etc.), hornblende; *hydroxy-:* talc; *Orthosilicates, hydroxy-:* chlorite (many varieties), serpentine (many varieties including chrysotile asbestus), sepiolite; *Carbonates:* calcite, dolomite, ankerite, magnesite; *Oxides:* magnetite; *hydroxide:* brucite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Silica: quartz, chalcedony, opal; *Carbonates:* aragonite, zaratite; *Hydrous silicate:* deweylite, genthite (garnierite); *Hydrous sulfate:* epsomite; *hydrous oxide:* limonite.

Magmatic deposits of chromite have been mined in the past in Southern Lancaster and Chester Counties, at Wood's mine, the Line Pit, and Scott's mine. At a number of localities actinolite and talc have been produced by the dehydration of serpentines by intrusive granites or pegmatites (see under Desilicated granitic pegmatites below).

PEGMATITES

SILICIC (GRANITIC) PEGMATITES

PRIMARY MINERALS:

Silica: quartz; *Trisilicates, feldspars:* orthoclase, microcline, albite, oligoclase; *Metasilicates, pyroxenes:* spodumene; *amphiboles:* hornblende; *misc.* beryl, iolite; *Orthosilicates, garnets:* almandite, spessartite; phenacite; *boro-:* tourmaline, dumortierite; *fluo-:* topaz; *micas:* lepidolite, muscovite, biotite; *rare-earth:* thorite, zircon, gadolinite, allanite; *Phosphates:* triphylite, lithiophyllite, *fluo-:* apatite, triplite, amblygonite; *rare-earth:* monazite, xenotime; *Columbates, tantalates, etc.:* fergusonite, columbite, tantalite, eschynite, polycrase, euxenite, samarskite, microlite; *Tungstates:* wolframite, scheelite; *Oxides:* chrysoberyl, rutile, cassiterite, uraninite, magnetite, ilmenite; *Fluorides:* cryolite; *Carbonates:* siderite; *Sulfides:* molybdenite, bismuthinite, pyrite, arsenopyrite, chalcopyrite; *Elements:* gold.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Silica: opal (hyalite); *Orthosilicates, hydroxy-:* vermiculite, kaolinite, allophane; *hydrous:* uranophane; *Hydrous oxides:* limonite, wad, gummite; *Phosphates, hydroxy-:* autunite, torbernite.

The granitic pegmatites are a familiar type of rock in southeastern Pennsylvania, forming intrusive dikes and veins in the various schists and gneisses.

Abnormal types occur in the meta-peridotite and meta-pyroxenite areas, due to the desilicating action of the serpentine upon the invading pegmatitic solutions. Evidence of reaction is to be seen in the zones of vermiculite (altered biotite), actinolite, and talc which lie between the abnormal pegmatites and the serpentine. The result of the reaction between the serpentine and the pegmatitic solutions was a depletion in the latter of silica, alumina, potash, and fluorine used in the production of the contact zones. The abstraction of most of this material caused the crystallization of the remainder into these abnormal pegmatites, one type of which consists solely of albite (albitite), and the other of albite or oligoclase, with corundum, tourmaline, and margarite (plumasite). Albitites occur at Sylmar, Nottingham, and Brinton's quarry, Chester County. Plumasites occur at

Unionville, Chester County, and at Morgan Station, and Black Horse, Delaware County. The mineralogy of the desilicated granitic pegmatites is simple:

DESILICATED GRANITIC PEGMATITES

PRIMARY:

Trisilicates, feldspars: albite, oligoclase, andesine; *Metasilicates:* beryl; *Orthosilicates, boro-:* tourmaline; *micas:* muscovite, biotite; margarite; *Oxides:* corundum, diaspore.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Hydroxy-orthosilicates: kaolinite, colerainite, vermiculite.

The minerals produced in the contact zone have been considered above under Magnesic igneous rocks.

ALKALIC PEGMATITES

PRIMARY MINERALS:

Trisilicates, feldspars: microcline, albite, oligoclase; *Metasilicates:* leucite; *Orthosilicates:* nephelite, cancrinite, sodalite, noselite; *Metasilicates, pyroxenes:* augite, acmite, aegirite; *amphiboles:* arfvedsonite, enigmatite; *Orthosilicates:* andradite; *boro-:* homilite; *micas:* biotite, lepidomelane; *Rare-earth silicates; acid:* eudidymite; *metasilicates:* rosenbuschite, låvenite, wöhlerite, hiortdahlite, eudialite, catapleiite, melanocerite, leucophanite; *orthosilicates:* zircon, thorite, schorlomite titanite, astrophyllite, mosandrite, neptunite, benitoite; *Phosphates:* xenotime; *Columbates:* polymignite; *Oxides:* ilmenite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Hydroxy-orthosilicates: kaolinite; *Hydrous oxides:* limonite, bauxite.

The alkalic pegmatites are exceedingly rare, being limited to a few localities in the world, and always associated with the alkalic igneous rocksf rom which they have been derived. No Pennsylvania occurrences are known.

CALCIC PEGMATITES

PRIMARY MINERALS:

Trisilicates, feldspars: microcline, albite, oligoclase, andesine, labradorite; *Metasilicates: pyroxenes:* augite; *amphiboles:* hornblende; *Orthosilicates:* andradite, wernerite; *micas:* biotite, phlogopite; *rare-earth:* zircon, titanite; *Phosphates:* apatite; *Carbonates:* calcite; *Fluorides:* fluorite; *Oxides:* rutile, magnetite, ilmenite; *Sulfides:* molybdenite, pyrite, pyrrhotite; *Elements:* graphite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Hydroxy-orthosilicates: kaolinite, vermiculite; *Silica:* chalcedony, opal; *hydrous oxide:* limonite.

The calcic pegmatites are quite rare, examples being the apatite-scapolite veins of Norway, and the nelsonite dikes of Virginia.

HYDROTHERMAL DEPOSITS

Economically, this group is one of the most important. The minerals may be best considered genetically with reference to the most prominent metal present. Contact deposits are included within this group, although the characteristic "contact" minerals formed are considered under the type of rock metamorphosed, Calcareous sediments, etc.

Non-metallic Minerals (Gangue)

PRIMARY:

Silica: quartz, chalcedony, opal; *Trisilicates, feldspars:* orthoclase (adularia, valencianite); *Metasilicates:* rhodonite; *Carbonates:* calcite, dolomite, ankerite, siderite, rhodochrosite; *Sulfates:* barite; *Fluorides:* fluorite.

Gold Minerals

PRIMARY:

Elements: gold; *Tellurides:* krennerite (calaverite), petzite, sylvanite; *Sulfides:* auriferous pyrite.

WEATHERING PRODUCTS:

Elements: gold.

Silver Minerals

PRIMARY:

Elements: silver; *Sulfides:* argentite; *Tellurides:* hessite, petzite, sylvanite; *Sulfarsenites:* proustite; *Sulfantimonites:* stephanite, pyrargyrite, polybasite.

HYDROMETAMORPHS: (Secondary enrichment minerals)

Sulfides: argentite; *Sulfarsenites:* proustite; *Sulfantimonites:* dyscrasite, stephanite, pyrargyrite, polybasite.

WEATHERING PRODUCTS:

Elements: silver, amalgam; *Halides:* cerargyrite, embolite, iodyrite.

Copper Minerals

PRIMARY:

Sulfides: chalcopyrite; *Arsenides:* tennantite, *Sulfarsenate:* enargite; *Sulfantimonites:* tetrahedrite; *Sulfbismutites:* emplectite.

HYDROMETAMORPHS: (Secondary enrichment minerals)

Sulfides: covellite, chalcocite, bornite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Halides: nantokite, atacamite; *Oxides:* cuprite, tenorite, melaconite; *Hydroxy-carbonates:* malachite, azurite, aurichalcite; *Hydrous silicate:* chrysocolla; *Hydroxy-sulfates:* brochantite; *Hydrous sulfates:* chalcanthite, linarite; *Hydroxy-phosphates:* libethenite, pseudomalachite; *Hydroxy-arsenates:* olivenite.

Lead Minerals

PRIMARY:

Sulfides: galena; *Sulfantimonites:* jamesonite, bournonite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Oxides: minium, massicot, plattnerite; *Carbonates:* cerussite; *Sulfates:* anglesite; *Chromates:* crocoite; *Tungstates:* stolzite; *Molybdates:* wulfenite; *Phosphates:* pyromorphite; *Arsenates:* mimetite; *Vanadates:* vanadinite, descloizite.

Zinc Minerals

PRIMARY:

Sulfides: sphalerite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Carbonates: smithsonite; *hydroxy-:* hydrozincite, aurichalcite; *Hydroxy-silicates:* calamine; *Hydroxy-phosphates:* hopeite, tarbuttite.

Iron Minerals

PRIMARY:

Sulfides: pyrite, chalcopyrite; *Oxides:* magnetite, hematite; *Carbonates:* siderite.

WEATHERING PRODUCTS:

Hydrous oxides: limonite.

Nickel Minerals

PRIMARY:

Sulfides: polydymite; *Arsenides:* niccolite, chloanthite; *Sulfantimonite:* ullmannite.

WEATHERING PRODUCTS: (in part hydrometamorphs)

Arsenates: annabergite; *Sulfates:* morenosite, lindackerite.

Cobalt Minerals

PRIMARY:

Sulfides: linnaeite, carrolite; *Arsenides:* smaltite; *Sulfarsenites:* cobaltite, glaucodot.

WEATHERING PRODUCTS:

Carbonates: spherocobaltite; *Arsenates:* erythrite.

Arsenic Minerals

PRIMARY:

Sulfides: realgar, orpiment.

WEATHERING PRODUCTS:

Sulfides: orpiment; *oxides:* arsenolite; *Elements:* arsenic.

Antimony Minerals

PRIMARY:

Elements: antimony; *Sulfides:* stibnite.

WEATHERING PRODUCTS:

Oxides: senarmontite, stibiconite, cervantite.

Mercury Minerals

PRIMARY:

Sulfides: cinnabar; *Selenides:* tiemannite, onofrite, coloradoite.

HYDROMETAMORPHS AND WEATHERING PRODUCTS:

Elements: mercury, amalgam; *Halides:* terlinguaite, eglestonite, montroydite, calomel.

The principal hydrothermal deposits of Pennsylvania are associated with intrusive Triassic diabase: the lead and zinc veins of Perkiomen and Phoenixville, and the contact magnetite deposits of Cornwall, French Creek, Fritz Island, and Boyertown.

FUMAROLIC DEPOSITS

PRIMARY:

Sulfates, anhydrous: mascagnite, aphthitalite, hydrocyanite, dolerophanite; *hydrous:* epsomite, picromerite, cyanochroite, voltaite; *Halides, anhydrous:* halite, sylvite, sal-ammoniac, hydrophilite, scacchite, cotunnite; *Oxides:* tenorite, massicot, hematite, magnesioferrite; *Hydroxides:* sassolite; *Elements:* sulfur.

SEDIMENTS

SILICEOUS AND ARGILLACEOUS SEDIMENTS

This group may be most conveniently subdivided as follows: (a) the unmetamorphosed sediments: the sands, gravels, sandstones, conglomerates, and shales; and (b) the metamorphosed sediments: slates, para-schists and para-gneisses.

UNMETAMORPHOSED

(Sands, gravels, sandstones, conglomerates, shales)

PRIMARY:

Silica: quartz, chalcedony, opal; *Trisilicates, feldspars:* orthoclase, microcline; *Hydroxy-orthosilicates:* muscovite, kaolinite, chlorite; *Hydrous-oxides:* limonite; *Carbonates:* calcite. (Cements: quartz, opal, limonite, calcite).

Accessory and Segregated Minerals

PRIMARY:

Orthosilicates: almandite; zircon, titanite; *Phosphates:* monazite; *Oxides:* corundum, spinel, hematite, magnetite, chromite, rutile, cassiterite, ilmenite; *Elements:* diamond, gold, platinum.

Epigenetic Concentrations

PRIMARY:

Sulfides: pyrite, galena, chalcopyrite, bornite, chalcocite.

WEATHERING PRODUCTS: (in part hydrometamorphs)

Hydroxides: goethite; *hydrous oxides:* limonite, wad; *hydroxy-carbonates:* malachite, azurite, *Phosphates:* carnotite, wavellite, strengite, cacoxentie, beraunite; *Vanadates:* volborthite, calciovolborthite.

The unmetamorphosed sediments may vary greatly in composition. While usually mechanically derived, they may in some cases be of chemical or organic origin. The character of the mechanically derived sediments depends largely on circumstances existing at the time of formation, and two important groups may be recognized, (a) those formed under water, and (b) the subaërial deposits, such as the familiar red sandstones, conglomerates and shales of the Triassic. The epigenetic concentrations listed above occur chiefly in sediments of subaërial origin, examples being the carnotite deposits of Mauch Chunk, and the chalcocite occurrences of Bradford and Tioga counties. Perhaps to be in-

cluded here are the residual goethite and limonite deposits caused by the weathering of the Cambro-Ordovician shales of Center, Cumberland, York, Lancaster, Berks, Chester, and Montgomery counties.

METAMORPHOSED

(Slates, para-schists and para-gneisses)

DYNAMIC METAMORPHS: (also contact metamorphs)

Silica: quartz; *Trisilicates, feldspars:* orthoclase, microcline, albite, oligoclase; *Metasilicates:* hornblende; *Orthosilicates:* almandite; *boro-:* tourmaline; *micas:* muscovite, biotite; chlorite; *oxy-:* cyanite, sillimanite, andalusite; zoisite, epidote, staurolite; zircon, titanite; *Phosphates:* apatite; *Oxides:* corundum, hematite, rutile, spinel, magnetite, ilmenite; *Sulfides:* pyrite, chalcopyrite; *Elements:* graphite.

WEATHERING PRODUCTS:

Hydroxy-silicates: kaolinite, chlorite, vermiculite; *Silica:* opal; *Hydrous oxides:* limonite; *Hydrous sulfates:* alunogen, halotrichite, kalinite.

CALCAREOUS AND MAGNESIAN SEDIMENTS

This group includes the limestones, and dolomites. Epigenetic concentrations of barite, celestite, galena, and sphalerite occur in Pennsylvania at the following places: Franklin County (barite), Blair County (celestite), Friedensville, Lehigh County (sphalerite), Lancaster County (galena).

PRIMARY:

Carbonates: calcite, dolomite, ankerite, siderite, aragonite. *Silica:* quartz, chalcedony, opal; *Hydroxy-silicates:* kaolinite; *Elements:* graphite.

DYNAMIC METAMORPHS:

Dynamo-metamorphism may cause recrystallizations of the above minerals, producing marbles from the limestone. A few of the minerals listed below may be formed.

CONTACT METAMORPHS:

Trisilicates, feldspars: orthoclase; *Metasilicates, pyroxenes:* diopside, schefferite, augite, wollastonite; *amphiboles:* tremolite, hornblende, edenite; *Orthosilicates, garnets:* grossularite, andradite; wernerite, vesuvianite, epidote, zoisite; *boro-:* danburite, tourmaline; *fluo-:* chondrodite; *micas:* phlogopite; *Fluo-phosphates:* apatite; *Oxides:* corundum, spinel, magnetite, ilmenite; *Sulfides:* pyrite, pyrrhotite, molybdenite; *Elements:* graphite; *Carbonates:* calcite, dolomite.

WEATHERING PRODUCTS: (in part hydrometamorphs)

Carbonates: calcite, aragonite.

Epigenetic Concentrations

HYDROMETAMORPHS:

Sulfides: pyrite, marcasite, galena, sphalerite; *Sulfates:* barite, celestite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Carbonates: cerussite, smithsonite; hydrozincite, aurichalcite; *Hydroxy-silicates:* calamine; *Hydrous sulfates:* goslarite.

Contact metamorphic minerals are of common occurrence in the limestones at Vanartsdalen's quarry, Bucks County; the Avondale-Doe Run district, Chester County; and at the Cornwall, French Creek, and Fritz Island iron mines.

FERRUGINOUS, MANGANIFEROUS, AND ZINCIFEROUS SEDIMENTS

Iron Deposits

PRIMARY:

Carbonates: siderite; *Silica:* chalcedony (jasper, chert); *Silicates:* kaolinite, glauconite; *Hydroxy-oxides:* goethite; *Hydrous oxides:* limonite; *Phosphates:* vivianite.

DYNAMIC METAMORPHS:

Oxides: hematite, magnetite.

Manganese Deposits

PRIMARY: (?)

DYNAMIC METAMORPHS:

Metasilicates: schefferite, rhodonite; *Orthosilicates:* tephroite; spessartite, piedmontite.

HYDROTHERMAL METAMORPHS:

Metasilicates: barysilite, ganomalite, hyalotekite; *Orthosilicates:* trimerite, harstigite, melanotekite, caryopilite, ganophyllite; *Phosphates, arsenates, etc.:* caryinite, ochrolite, berzeliite, monimolite, ecdemite, synadelphite, flinkite, arseniopleite, manganstibiite, sarkinite; *Borates:* pinakiolite; *Oxides:* langbanite, jacobsite, pyrochroite.

WEATHERING PRODUCTS:

Oxides: psilomelane, wad.

Iron-Manganese-Zinc Deposits

PRIMARY: (?)

DYNAMIC METAMORPHS:

Metasilicates: schefferite, rhodonite; *Orthosilicates:* spessartite, tephroite, willemite; *Oxides:* zincite, franklinite, gahnite.

HYDROTHERMAL METAMORPHS:

Silicates: nasonite, glaucochroite, hancockite, clinohedrite, hodgkinsonite, roeblingite, leucophoenicite, bementite; hardystonite, *Borates:* sussexite; *Carbonates:* rhodochrosite.

WEATHERING PRODUCTS: (in part Hydrometamorphs)

Carbonates: smithsonite, hydrozincite; *Hydroxy-silicates:* calamine; *Hydroxides:* chalcophanite; *Hydrous oxides:* limonite.

While ferruginous deposits of sedimentary origin are well known, the metamorphosed manganese and iron-manganese-zinc deposits are exceedingly rare, the former type being illustrated by the deposit at Langban, Sweden, and the latter by the deposits at Franklin, and Sterling Hill, New Jersey. These deposits are to be regarded genetically, as the result of a sequence of unusual circumstances.

SALINE RESIDUES

PRIMARY:

Carbonates: calcite, aragonite, dolomite, strontianite; *hydrous:* natron, trona; *chloro-:* kainite; *Sulfates, anhydrous:* anhydrite, celestite, barite, thenardite, glauberite; *hydrous:* mirabilite, kieserite, epsomite, gypsum, polyhalite; *Borates:* boracite, borax, howlite, ulexite; *Nitrates:* soda-niter, niter; *Chlorides:* halite, sylvite, carnallite.

PHOSPHATIC DEPOSITS

PRIMARY:

Phosphates: phosphorite; and a number of indefinite mixtures of phosphates of various elements such as guana, osteolite, staffelite, etc.

HYDROMETAMORPHS:

Phosphates, normal hydrous: struvite, collophanite, bobierrite, minervite; *acid hydroxy-:* monetite; *acid hydrous:* stercorite, brushite, martinite, newberryite; *Sulfates:* mascagnite; *Carbonates:* teschemacherite; *Oxalates:* oxammite.

CARBONACEOUS DEPOSITS[8]

Amber Series

Hydrocarbons, simple: scheerite, ozocerite, fichtelite, hartite, könlite; *oxygenated:* succinite, retinite, bathvillite, dysodile, pyroretinite, leucopetrite, geomyrite, geocerite, bombiccite, dopplerite.

Petroleum Series

Hydrocarbons: petroleum, asphaltum, elaterite.

Coal Series

PRIMARY:

Hydrocarbons: peat.

DYNAMIC METAMORPHS:

Hydrocarbons: lignite, cannel coal, bituminous coal, anthracite. *Elements:* graphite.

[8] Little is known of the genetic history of these substances, with the exception of the coal series.

III

GENERAL GEOLOGY OF PENNSYLVANIA

PHYSIOGRAPHIC DIVISIONS[9]

Provinces	Character	Geology
Coastal Plain	Lowland sloping toward the Atlantic. (Extreme eastern edge of state only.)	Unconsolidated Cretaceous, Tertiary, and Quaternary sand, gravel, and clay, on a basement of gneiss and schist.
Piedmont Plateau	A moderately elevated sloping upland, above which rise residual monadnocks, which have been more resistant to erosion.	Crystalline gneiss, schist, etc., and Cambro-Ordovician quartzite, schist, and limestone in the southern part. Triassic sandstone, shale, conglomerate, and intrusive diabase in the northern part.
Highland Province	Low hills; a southern extension of the Highlands of northern New Jersey, and southern New York.	Precambrian crystalline gneiss, schist, limestone, etc., and Cambro-Ordovician quartzite, limestone, etc.
Blue Ridge Province	Low maturely dissected mountains, marking the northern extension of the Blue Ridge and Catoctin Mountains of Maryland and Virginia.	Metamorphosed Precambrian volcanic rocks: basalt and rhyolite; Cambrian quartzite.
Appalachian Ridge and Valley Province	A series of long, parallel, even crested ridges, with intervening valleys.	Highly folded Paleozoic sandstone, quartzite, shale, limestone, etc.
Appalachian Plateau	Plateau of moderate to low relief, glaciated in the northern part.	Devonian, Mississippian, Pennsylvanian, and Permian sandstone, shale, limestone, fire clay, coal, etc.

GENERAL GEOLOGY OF THE PIEDMONT SOUTH OF THE TRIASSIC BELT[10]

Ordovician

Formation	Character	Minerals
Octoraro schist	Quartz-muscovite schist, with pronounced lamination. The laminae are bluish or grayish-green, with a silvery luster. The lower beds are more calcareous and siliceous.	Chief constituents: quartz, muscovite, orthoclase, chlorite. Accessory: plagioclase, biotite, tourmaline, apatite, perovskite? magnetite, ilmenite, and pyrite more or less altered to limonite.

[9] Cf. Nevin M. Fenneman, Physiographic divisions of the United States: Annals Assoc. Am. Geographers, 6, 19–98, 1916.

[10] Theodore Rand, Notes on the geology of southeastern Pennsylvania: Proc. Acad. Nat. Sci. Phila., 44, 174–202, 1892.

F. Bascom, Philadelphia and Trenton folios: U. S. Geol. Survey. Geologic folios 162 and 167, 1909.

Edson S. Bastin, Feldspar deposits of the United States: U. S. Geol. Surv. Bull., 420, 63–72, 1910.

B. L. Miller, Graphite deposits of Pennsylvania: Top. & Geol. Surv. Penna. Rep., 6, 1912.

T. Nelson Dale, Slate in the United States: U. S. Geol. Surv. Bull., 586, 110–115, 1914.

Eleonora F. Bliss and Anna I. Jonas, Relation of the Wissahickon gneiss to the Shenandoah limestone and Octoraro schist of the Doe Run and Avondale region, Chester County, Pennsylvania: U. S. Geol. Surv. Prof. Paper 98-B, 1916.

The age of the Wissahickon gneiss is in dispute. The work of Rand indicates the formation to be Paleozoic, and his conclusions are adopted here. The other authors listed above have considered the formation to be Precambrian.

Peachbottom slate member	Quartz-sericite-chlorite schist, sometimes calcareous; and dark gray, slightly bluish, slate.	Chief constituents: quartz, muscovite, and chlorite. Accessory: andalusite, graphite, magnetite, rutile, and zircon.
Wissahickon mica gneiss	Quartz-feldspar-mica gneiss or schist; silvery gray to greenish, medium to coarse-grained. Often so thoroughly injected by metagabbro and pegmatite, as to form an injection-gneiss. The folia are usually wavy, and the beds show minute crumpling and folding.	Chief constituents: quartz, feldspars, biotite, and muscovite. Accessory: garnet, tourmaline, sillimanite, zoisite, apatite, zircon, and magnetite, and locally: staurolite, cyanite, or andalusite.
	Cambro-Ordovician	
Shenandoah limestone	A heavily bedded, crystalline, white or blue, siliceous and magnesian limestone, with interbedded siliceous or micaceous schist.	Chief constituents: calcite and dolomite. Accessory: quartz, feldspar, phlogopite, graphite, pyrite, and siderite.
	Cambrian	
Chickies formation	Massive quartzite, with a conglomeratic base, and siliceous slate, sericite schist, or quartz schist. A considerable thickness of micaceous feldspathic material occurs interbedded with the quartzite west of the Philadelphia district.	Chief constituents: quartz and feldspar. Accessory: stretched or broken tourmaline crystals, staurolite, apatite, perovskite? zircon, hematite and magnetite. Locally the quartzite may contain geodes lined with quartz crystals.
	Precambrian	
Baltimore gneiss	A light to dark gray, medium grained, massive or gneissic rock, sometimes pseudo-porphyritic. The gneiss is locally very thoroughly injected by gabbro, and constitutes a composite formation. The gneissic facies shows a fine and intensely plicated banding.	Chief constituents: quartz, feldspar, hornblende, and biotite. Accessory: epidote, garnet, titanite, and zircon.
Franklin limestone	A coarsely crystalline marble, usually darkened in color by the presence of silicates. The formation is often thoroughly injected with gabbro. The Franklin limestone occurs intimately associated with the Pickering gneiss and may constitute but a phase of that formation.	Chief constituent: calcite. Accessory: orthoclase, oligoclase, bytownite, pyroxene, amphibole, scapolite, phlogopite, apatite, and titanite.
Pickering[11] gneiss	Graphitic gneiss and quartz-schist, variable in composition.	Chief constituents: quartz, feldspars, hornblende, biotite, calcite and much graphite.
	Igneous Rocks	
Granitic pegmatite	Coarse grained quartz-microcline rocks, or smoky quartz veins forming irregular masses, more or less lens-shaped, or dikes.	Chief constituents: quartz, microcline, albite, oligoclase, muscovite biotite, tourmaline, garnet, and beryl. Many rare minerals occur in the pegmatites. No regularity is shown in the distribution of the minerals.
Albitite and Plumasite: (desilicated granitic pegmatite)	Coarse grained rocks occurring as intrusive masses in meta-peridotite, or at the contact of meta-peridotite and Wissahickon gneiss.	Chief constituents: albite, oligoclase, tourmaline, margarite, muscovite, and corundum. Zones of chlorite, talc, chrysotile, and vermiculite occur adjacent to the veins.

[11] F. Bascom, quoted by B. L. Miller, l. c., 1912.

Metapyroxenite and metaperidotite	Serpentine, talc, anthophyllite and chlorite schists. Unaltered pyroxenite is uncommon in Pennsylvania. The metapyroxenites and metaperidotites are genetically connected with the gabbros, occurring as peripheral masses to the gabbro, or as bodies in or near it.	The primary minerals are olivine and enstatite, with accessory chromite and magnetite. Minerals developed by hydrothermal metamorphism include hornblende, actinolite, tremolite, asbestus, epidote, talc, chlorite, serpentine, and magnetite. Quartz (drusy), chalcedony, magnesite, sepiolite, and deweylite, are produced by weathering.
Granite gneiss	A medium to coarse grained, light colored, gneissic or massive rock. Along the contact with Wissahickon gneiss an injection gneiss (with a porphyritic structure) has been produced by the penetration of the, magma parallel to planes of fissility.	Chief constituents: quartz, orthoclase or microcline, biotite, and hornblende. Accessory: actinolite, epidote, apatite, and titanite.
Hornblende gneiss	Dark colored, medium grained gneiss.	Chief constituents: hornblende, orthoclase, microcline, oligoclase, biotite, and quartz. Accessory: epidote, apatite, and titanite.
Metagabbro	Dark colored, massive to thoroughly schistose dikes in the Baltimore and Wissahickon gneisses.	Chief constituents: hornblende, feldspar (chiefly plagioclase), and quartz. Accessory: biotite, garnet, actinolite, anthophyllite, zoisite, chlorite, muscovite, pyrite, and titanite.
Gabbro and norite, and diorite	A medium grained, massive or more or less schistose rock. Typically a hypersthene-augite-plagioclase rock.	Chief primary constituents: hypersthene, augite, and labradorite, with accessory quartz, biotite, orthoclase, titanite, magnetite, apatite, and pyrrhotite. Metamorphic products are actinolite, chlorite, garnet, and serpentine. Narrow "reaction rims" of garnet occur between the pyroxene and labradorite. On the inner margin of the rims there may be a zone of quartz and hornblende.

General Geology of the Triassic Belt of the Piedmont

Triassic: Newark Group[12]

Formation	Character	Thickness
Brunswick shale	Soft red shales, with a few purple, green, yellow, and black layers, and some local sandstone layers. Lenticular masses of green shale occur locally. Ripple marks, mud cracks, rain drop impressions, and glauberite crystal cavities.	4000–5000′

[12] Arthur C. Spencer, Magnetite deposits of the Cornwall type in Pennsylvania: U. S. Geol. Surv. Bull., 359, 1908.

N. H. Darton, Philadelphia and Trenton folios: U. S. Geol. Surv. folios, 162 and 167, 1909.

Edgar T. Wherry, Contributions to the mineralogy of the Newark group in Pennsylvania: Trans. Wagner Free Inst. Science, 7, 7–27, 1910. The Newark copper deposits of southeastern Pennsylvania: Econ. Geol., 3, 726–738, 1908. Silicified wood from the Triassic of Pennsylvania: Proc. Acad. Nat. Sci. Phila., 1912, 366–372; Age and correlation of the "New Red" or Newark Group in Pennsylvania: Proc. Acad. Nat. Sci. Phila., 1912, 373–379. Glauberite crystal cavities in the Triassic rocks of eastern Pennsylvania: Am. Min., 1, 37–43, 1916.

George W. Stose and J. Volney Lewis, Triassic igneous rocks in the vicinity of Gettysburg, Pennsylvania Bull. Geol. Soc. America, 27, 623–644, 1916.

Anna I. Jonas, The Precambrian and Triassic diabase in eastern Pennsylvania: Bull. Am. Mus. Nat. Hist., 37, 173–181, 1917.

George W. Stose, Glauberite crystal cavities in the Triassic rocks in the vicinity of Gettysburg, Pa.: Am. Min., 4, 1–4, 1919.

Triassic: Newark Group (Continued)

Formation	Character	Thickness
Lockatong formation	Hard, dark gray to purple shales, black and purplish argillite, dark gray and green flagstone, and some thin layers of calcareous shale. Ripple marks, mud cracks, and rain drop impressions occur at all horizons.	2000–3000′
Stockton formation	Gray to buff, coarse, arkosic conglomerate; yellow micaceous sandstone or freestone; and soft red argillaceous shale. Layers of green, purple, and black shales occur at all horizons. Many of the sandstones are crossbedded, and exhibit ripple marks, mud cracks, and rain drop impressions.	3500–4000′

Igneous Rocks

Formation	Character
Basalt	Extrusive sheets two miles south of Jacksonwald, Berks County, and south of Bendersville, Adams County. Two types occur: Dense black basalt, in places vesicular, and having a glassy groundmass. Olivine basalt, with abundant olivine. Basalt may also develop as a contact facies of diabase.
Diabase	Intrusive sheets and dikes. The following types occur: (1) Normal augite-labradorite diabase. (2) Feldspathic diabase or anorthosite. (3) Quartz diabase with abundant quartz. (4) Micropegmatite, consisting largely of micrographic quartz and orthoclase. (5) Aplite. Essentially a quartz-orthoclase rock. (6) Hypersthene diabase. (7) Olivine diabase, with abundant olivine. The feldspar may occur altered to fine scaly (apparently sericitic) aggregates, or kaolin. The pyroxene is often altered to uralitic amphibole, or to serpentine, chlorite, and magnetite. Epidote is abundant in places. Genetically connected with the diabase are the hydrothermal veins of galena and sphalerite of Montgomery and Chester County, and the contact deposits of magnetite of the Cornwall type.

GENERAL GEOLOGY OF LEBANON, BERKS, LEHIGH, AND NORTHAMPTON COUNTIES[13]

Ordovician

Formation	Character	Thickness
Martinsburg shale	Black shale, with interbedded layers of dark colored sandstone in the middle portion. In the vicinity of Nazareth, Bangor, and Slatington, the shale has been metamorphosed to slate. Pyrite is common locally.	3000′
Nazareth formation (Lower Trenton)	Gray to black shaly limestone (cement rock). Replaced toward the west and south by Martinsburg shale.	0–500′
Nisky or Lehigh limestone (Black River)	Gray to black shaly limestone. An important cement rock.	100′

[13] Edgar T. Wherry, The early Paleozoic of the Lehigh Valley district, Pennsylvania: Science, 30, 416, 1909.
Benjamin L. Miller, The mineral pigments of Pennsylvania: Top. & Geol. Surv. Penna., Rep. 4, 1911.
Frederick B. Peck, Preliminary report on the talc and serpentine of Northampton County and the Portland cement materials of the Lehigh district: Top. & Geol. Surv. Penna., Rep. 5, 1911.
H. N. Eaton, The geology of South Mountain at the junction of Berks Lebanon, and Lancaster Counties, Pennsylvania: Jour. Geol., 20, 331–343, 1912.
Anna I. Jonas, The Precambrian and Triassic diabase of eastern Pennsylvania: Bull. Am. Mus. Nat. Hist., 37, 173–181, 1917.
Edgar T. Wherry, Precambrian sedimentary rocks in the Highlands of eastern Pennsylvania: Bull. Geol. Soc. Am., 29, 375–392, 1918.
Samuel G. Gordon, Ordovician basalts and quartz diabases in Lebanon County, Pennsylvania: Proc. Acad. Nat. Sci. Phila., 72, 354–357, 1920.

Coplay limestone (Beekmantown)	Dark bluish-gray, thick bedded dolomitic limestone passing upward into thinner beds of mottled magnesian limestone with interstratified beds of pure limestone. Some shaly layers are present. Veins of quartz, calcite, and dolomite filling joints are common.	1500′

Cambrian

Formation	Character	Thickness
Allentown limestone (Upper C)	Massive beds of white to gray dolomite or dolomitic limestone, with frequent bands of oölitic material, the upper surface of which is often covered with the coral-like *Cryptozoon proliferum*.	2000′
Leithsville or Tomstown formation (Lower Middle C)	Buff colored sandy shale and shaly limestone with occasional strata of compact thick bedded limestone containing nodules of black to gray chert.	1500′
Hardyston quartzite (Lower C)	Bluish or grayish quartzite, with a coarse conglomerate at the bottom. The uppermost member is a fine grained, almost jaspery, highly ferruginous quartzite. Circulating waters have converted the quartzite along the northwest flank of South Mountain into a ferruginous chert, chert breccia, or brown iron ore.	0–400′

Precambrian

Formation	Character	Minerals
Franklin limestone	A coarsely crystalline limestone, very faintly stratified. The rock has been greatly metamorphosed, and often has lost its identity. It occurs interstratified with the formations below.	Principal minerals: calcite, diopside, tremolite, biotite, serpentine, asbestus, apatite, and titanite.
Quartz-mica schist	Quartz-mica schist, quartzite, and muscovite schist. Orthoclase has been extensively introduced where emanations from igneous magmas have acted on the rock. The extreme action of the magma is represented by finely banded gneisses.	Chief constituents: quartz, sericite, and sillimanite. Accessory minerals (locally abundant): garnet, tourmaline, biotite, apatite, zircon, ilmenite, and pyrite.
Graphitic quartzite (Pickering gneiss)	A bluish-gray quartzite when least altered, but feldspar and other constituents have been extensively introduced by invading magmas.	Chief constituents: quartz, and graphite. Accessory: feldspars, garnet, biotite, zircon, apatite, and pyrite.
Basic (amphibolite) gneiss	Dark colored gneiss. Individual bands persist for considerable distances, but the gneisses vary rapidly across the bands. Occurs interbedded with the graphitic quartzite, limestone, and quartz-mica schist.	Chief constituents: quartz, hornblende (or biotite or augite), orthoclase and oligoclase. Accessory: ilmenite, magnetite, and rounded zircons.

Ordovician (Igneous Rocks)

Basalt	Dark greenish or black amygdaloidal tuffs or breccias, vesicular on weathering.	Chief constituents: glass; labradorite and augite; calcite amygdules.
Quartz diabase	Dark greenish-black, fine grained to porphyritic rock.	Chief constituents: augite, labradorite, and magnetite, with interstitial graphic intergrowths of quartz and orthoclase.

Precambrian (Igneous Rocks)

Formation	Character	Minerals
Pegmatite	Veins and lenses of quartz and feldspar rocks are common in the various gneisses.	Principal minerals: quartz, microcline, albite, garnet, beryl, tourmaline, muscovite, and biotite.
Diabase	Dikes cutting the other Precambrian rocks. The rock is quite dark, and generally fine grained.	Chief constituents: augite and labradorite, with characteristic accessory pyrrhotite and quartz. Chlorite, uralite, and zoisite, occur as alteration products.
Losee (dioritic) gneiss	A light colored, sometimes white, gneiss.	Chief constituents: quartz, oligoclase, diopside, hornblende, and biotite, with accessory apatite, titanite, zircon, and magnetite.
Byram (granitic) gneiss	Light colored, medium to fine grained rock.	Chief constituents: quartz, orthoclase and microperthite, biotite, epidote, chlorite, and magnetite.
Pochuck (gabbroic) gneiss	A dark, medium to fine grained, gabbroic gneiss.	Chief constituents: feldspar, pyroxene (augite generally altered to hornblende), and magnetite.

GENERAL GEOLOGY OF FRANKLIN, ADAMS, AND CUMBERLAND COUNTIES[14]

Ordovician

Formation	Character	Thickness
Martinsburg shale	Black shale with yellowish-green, sandy strata in the upper portion. The lower part is black, carbonaceous and fissile. Slaty cleavage is common.	2000′
Chambersburg limestone	Thin bedded, fossiliferous limestone with argillaceous partings.	100–750′
Stones River limestone	Pure limestone with magnesian layers. Thin beds of chert occur in the middle. Calcite veins are common in the lower beds.	675–1050′
Beekmantown limestone	Thick bedded, rather pure limestone interbedded with magnesian beds and fine grained pink to white marble. Beds of oölite, fine conglomerate, chert layers, and quartz geodes occur at several horizons. The basal member (Stonehenge siliceous limestone member) is a blue limestone, with hard siliceous laminae, coarse "edgewise conglomerate," and purer fine grained marble. Small rosette cherts occur at the top.	2300′

Cambrian

Formation	Character	Thickness
Conococheague limestone (Upper C)	Thin bedded blue limestone with thin wavy sandstone laminae. The base of the formation is marked by siliceous beds and conglomerate, with interbedded oölitic limestone, dark shaly limestone with red clay partings, and *Cryptozoon* beds. Large scoriaceous cherts are common in the residual soil.	1635′

[14] F. Bascom, The ancient volcanic rocks of South Mountain, Pennsylvania: U. S. Geol. Surv., Bull. 136, 1896.

Charles D. Walcott, The Cambrian rocks of Pennsylvania: U. S. Geol. Surv. Bull., 134, 1896.

George W. Stose, Mercersburg-Chambersburg Folio: U. S. Geol. Surv. folio, 170, 1910.

George W. Stose, The copper deposits of South Mountain, in Pennsylvania: U. S. Geol. Surv. Bull. 430, 122–129, 1910.

Edgar T. Wherry, The copper deposits of Franklin-Adams Counties, Pennsylvania: J. Frank. Inst., 171, 151–162, 1911.

Elbrook formation (Middle C)	Gray to light blue shaly limestone and calcareous shale, with some green layers and red bands. Beds of pure massive limestone occur at the base. Near the middle are massive beds of dolomite and quartzitic limestone.	3000′
Waynesboro formation (Middle C)	Gray slabby calcareous sandstone, red and purple shale, and minor limestone. Dark blue limestone, dolomite, and fine grained white marble occur near the middle. The upper shale and sandstone are ripple marked.	1000′
Tomstown limestone (Lower C)	Massive and thin bedded limestone, in part cherty and magnesian, with considerable interbedded shale near the base. Pure white sericite schist, and a coarse, fetid dolomite occur near the base.	1000′
Antietam sandstone (Lower C)	Coarse grained, white and bluish gray quartztite, with numerous *Scolithus* tubes.	500–800′
Harpers schist (Lower C)	Schist, hackly slate, and soft sandstone, with a heavy sandstone or quartztite, Scolithus-bearing, (Montalto quartz member) near the middle.	2750′
Weverton sandstone (Lower C)	Feldspathic sandstone and purplish conglomerate consisting of fragments of Precambrian rhyolite and quartz grains. These rocks have sometimes been metamorphosed to quartz schist.	1250′

Precambrian (Igneous Rocks)

Formation	Character	Minerals
Quartz porphyry (rhyolite)	Deep red to dark blue, porphyritic. Occurs as intrusive masses.	Chief constituents: colorless or red quartz, and white, pink, or red twinned orthoclase phenocrysts in a ground-mass of quartz and orthoclase. Secondary piedmontite occurs through the porphyry, and as radiating aggregates in veins and cavities.
Aporhyolite	Red, pink, purplish, or bluish gray, compact and fine grained rocks representing devitrified rhyolite. Fluidal, micropoikilitic, spherulitic, axiolitic, lithophysal, rhyolitic, micropegmatitic, perlitic, taxitic, amygdaloidal, and trachitic structures characterize the rock. Both flow breccia and tuff occur. An intense metamorphism of the aporhyolites is represented by sericite schist.	The aporhyolite consists of feldspars, quartz, and biotite phenocrysts in a groundmass of quartz, feldspar, and secondary epidote. Amygdules are filled with quartz and epidote.
Metabasalt	Green, amygdaloidal, massive, schistose, or slaty rocks. Crushed, sheared, and veined rocks were produced by intense metamorphism.	The original constituents, plagioclase, pyroxene, olivine, and magnetite, have been replaced by actinolite, epidote, and chlorite. The amygdules are filled with epidote, cuprite, and specular hematite. Mineralization has occurred locally along epidotized shear zones with the deposition of copper.

General Geology of the Appalachian Provinces[15]

Post-Carboniferous[16] (*Igneous Rock*)

Formation	Character	Minerals
Peridotite	But a single occurrence of an igneous rock is known from the Appalachian provinces—a peridotite dike, intrusive in the Carboniferous sediments two and a half miles northwest of Masontown, Fayette County. The average thickness of the dike is about 3 feet on the surface, but it attains a thickness of 10 feet in the Waynesburg coal.	The rock is composed of phenocrysts of olivine partially altered to serpentine, reddish-brown biotite, and accessory garnet, apatite, magnetite, perovskite, and pyrite. Inclusions of coke, and of other rocks, are numerous.

Permian[17]

Formation	Character	Thickness
Greene formation	Chiefly sandstone and shale, with some interbedded limestone and minor beds of coal.	700′
Washington formation	Sandstone, shale, limestone, and coal.	400′

Pennsylvanian[18]

Formation	Character	Thickness
Monongahela formation	Sandstone, shaly sandstone, limestone, and important coal beds.	260–380′
Conemaugh formation	Sandstone, red shale, limestone, and coal.	700′
Allegheny formation	Limestone, sandstone, and coal.	300′
Pottsville formation	Sandstone, shale, iron ore, coal, and some limestone and fire clay. The basal member is called the Sharon conglomerate.	300′

Mississippian[18]

Formation	Character	Thickness
Mauch Chunk formation	Subaërial deposits of red shale with some sandstone and limestone. Two limestone members are included: the Loyalhanna limestone at the base, and the Greenbrier limestone.	180–1000′

[15] The following folios on the region have been issued by the U. S. Geological Survey: Nos. 82, 92, 93, 94, 102, 110, 115, 121, 123, 125, 133, 134, 144, 146, 160, 170, 172, 174, 176, 177, 178, 179, 180, and 189.

[16] J. F. Kemp and J. G. Roes, A peridotite dike in the coal measures of Southwestern Pennsylvania: Annals N. Y. Acad. Sci., 17, 509–518, 1907.

Lloyd B. Smith, A peridotite dike in Fayette and Greene Counties: Top. & Geol. Surv. Penna. Rep., 1910–1912, 150–155, 1912.

[17] John J. Stevenson, Carboniferous of the Appalachian Basin: Bull. Geol. Soc. America, 18, 29–178, 1907.

Ralph W. Stone, Review of general geology of southwestern Pennsylvania in light of recent work: Top. & Geol. Surv. Penna., 1906–1908, 120–340, 1918.

[18] John J. Stevenson, Carboniferous of the Appalachian Basin: Bull. Geol. Soc. America, 15, 37–210, 1904; 17, 65–228, 1906; 18, 29–178, 1907.

Ralph W. Stone, Review of general geology of southwestern Pennsylvania in light of recent work: Top. & Geol. Surv. Penna. Rep., 1906–1908, 120–340, 1918.

Frederick G. Clapp, Limestones of southwestern Pennsylvania: U. S. Geol. Surv. Bull., 249, 1905.

[19] John J. Stevenson, Carboniferous of the Appalachian Basin: Bull. Geol. Soc. America, 14, 15–96, 1903.

Joseph Barrell, Origin and significance of the Mauch Chunk shale: Bull. Geol. Soc. America, 18, 449–476, 1907.

Pocono formation	Thick-bedded gray sandstone and shale. Three members are included: Berea sandstone at the base; Cuyahoga sandstone and shale; and Burgoon sandstone, at the top.	1400′

Devonian[20]

Formation	Character	Thickness
Catskill formation	Red arkosic sandstone and shale, with some gray and greenish shale, and gray sandstone, (subaĕrial deposits).	2500′
Chemung formation	Alternating beds of greenish-gray, brown, or purplish shale, and thin sandstone members: Pine Ridge sandstone at the base, the Allegrippis sandstone, and Saxton conglomerate, respectively, above and below the middle.	2400–3500′
Brallier shale (Upper Portage)	Fine grained, siliceous shale, largely composed of wavy and dimpled laminae, with a few sandstone layers.	1350–1800′
Harrell shale (Lower Portage)	Dove colored and black fissile (paper) shale. Black at the bottom toward the west (Burket member), and interbedded black and dove colored to the east.	250′
Hamilton formation	Very dark green shale with thin bluish sandstone layers. Dark olive shale in the lower portion. A bed of limestone (Tully?) occurs at the top.	800–1200′
Marcellus shale	Black fissile shale.	150′
Onondago formation	Dark shale with limestone layers.	50′
Oriskany formation	A coarse thick bedded sandstone (Ridgeley sandstone), overlying a thin bedded siliceous limestone (Shriver limestone).	300′
Helderberg[21] formation	Thick bedded gray limestone, with some shale. Some parts have much bedded chert. The limestone varies from a coarse agglomeration of fossil fragments to a dense fine grained subcrystalline rock. Three members are recognized in Pennsylvania: the Keyser limestone at the base, the Coeymans limestone, and the New Scotland limestone.	150′

Silurian[22]

Formation	Character	Thickness
Tonoloway[23] limestone (Cayugan)	Laminated, fine grained gray, buff, or cream colored limestone and calcareous shale.	400′
Wills Creek shale (Cayugan)	Dove colored calcareous, fissile shale, with a little limestone. The bottom consists of red and green shale, impure limestone, and red sandstone (Bloomsburg red member).	600′
McKenzie limestone (Cayugan)	Limestone and shale.	275′

[20] George W. Stose, Mercersburg-Chambersburg folio: U. S. Geol. Surv. folio, 170, 1910.

John B. Reeside, Jr., The Helderberg limestone of Central Pennsylvania: U. S. Geol. Surv. Prof. Paper 108-K, 1917.

Charles Butts, Geologic section of Blair and Huntingdon Counties, Central Pennsylvania: Am. J. Sci., 46, 523–537, 1918. The Devonian section near Altoona, Pennsylvania: J. Geol., 14, 618–630, 1906.

[21] The Stormsville is included in this group. In some of the older reports some Helderberg limestone was included in the Lewistown.

[22] George W. Stose, Mercersburg-Chambersburg folio; and Pawpaw-Hancock folio: U. S. Geol. Survey folios, 170 and 179, 1910 and 1912.

Charles Butts, Geologic section of Blair and Huntingdon Counties, Central Pennsylvania: Am. J. Sci., (4) 46, 523–537, 1918.

Charles Schuchert, Silurian formations of southeastern New York, New Jersey, and Pennsylvania: Bull. Geol. Soc. America, 27, 531–554, 1916. The lower Silurian is there collectively called the Shawangunk.

John B. Reeside, Jr., The Helderberg limestone of Central Pennsylvania: U. S. Geol. Surv. Prof. Paper 108K, 1917.

[23] Formerly known as Bossardville or Lewistown limestone.

Silurian (Continued)

Formation	Character	Thickness
Clinton formation (Niagaran)	Grayish, greenish or pink, soft, fissile shale, with heavy sandstone and quartzite beds. The uppermost sandstone is a hard quartz flagstone (Keefer sandstone). Below this is a zone of red sandstone and quartzite, in some places ferruginous enough to constitute an iron ore.	800′
Tuscarora sandstone (Medinian)	Thick beds of a hard, resistant, granular, white sandstone, extensively used for silica brick, and commonly called ganister. It is a prominent mountain making rock, forming the crests of the ridges, and a great talus covering the slopes.	400′
Juniata formation (Medinian)	Soft red shale, and cross-bedded sandstone, with some conglomerate.	400–850′
Oswego sandstone	Medium thick-bedded gray sandstone.	800′

Ordovician[24]

Formation	Character	Thickness
Reedsville shale (Upper Ordovician)	Shale with thin limestone layers, and fissile shale. Thick dark sandstone occurs at the top, and black shale with graptolites at the bottom.	1000′
Trenton limestone	Thin black limestone weathering with a gray film on the surface.	320′
Rodman limestone	Dark crystalline limestone weathering with a rough granulated surface.	30′
Lowville limestone	Dark, thick bedded, pure limestone.	180′
Carlim limestone	Dark, fine grained, limestone, with an argillaceous limestone member (Lemont member).	180′
Bellfonte dolomite (Beekmantown)	Thick bedded dolomite with much chert.	1000′
Axeman limestone (Beekmantown)	Thin bedded blue limestone with dolomite layers.	100′
Nittany dolomite (Beekmantown)	Thick bedded, cherty dolomite.	1000′

Cambrian[25]

Formation	Character	Thickness
Larke dolomite (Upper C)	Thick bedded, coarse, steely blue dolomite.	250′
Mines dolomite (Upper C)	Chert and oolitic dolomite, with much oolitic and platy scoriaceous chert, and Cryptozoon beds.	250′
Gatesburg formation (Upper C)	Thick bedded, steely blue, coarsely crystalline dolomite, with interbedded quartzite layers. Silicified oolites are a characteristic feature of the formation. A coarse thick bedded, steely blue dolomite occurs at the bottom (Stacy dolomite member), and a thin bedded blue limestone in the upper part (Ore Hill limestone member).	1750′

[24] Victor Ziegler, The siliceous oolites of Central Pennsylvania: Am. J. Sci., (4) 34, 113–127, 1912.
Charles Butts, Geologic section of Blair and Huntingdon Counties, Central Pennsylvania: Am. J. Sci., (4) 46, 523–537, 1918.

[25] Victor Ziegler, The siliceous oolites of Central Pennsylvania: Am. J. Sci., (4) 34, 113–127, 1912.
Charles Butts, Geologic section of Blair and Huntingdon Counties, Central Pennsylvania: Am. J. Sci., (4) 46, 523–537, 1918.

Warrior limestone (Upper C)	Thick and thin bedded blue limestone with thin siliceous shaly partings, a few thin quartzite layers, and an occasional bed of limestone. Cryptozoa are common, and oolite is present.	250′
Pleasant Hill limestone (Upper C)	Thick bedded limestone at the top, with argillaceous thin bedded limestone at the bottom weathering to shale.	600′
Waynesboro formation (Middle C)	Sandstone, conglomerate, and red and greenish shale.	250′

IV

DESCRIPTIVE MINERALOGY OF PENNSYLVANIA

NATIVE ELEMENTS

GRAPHITE	C	Rhombohedral
SULFUR	S	Orthorhombic
BISMUTH	Bi	Rhombohedral
GOLD	Au	Isometric
SILVER	Ag	Isometric
COPPER	Cu	Isometric
TIN	Sn	
PLATINUM	Pt	Rhombohedral

GRAPHITE

C — RHOMBOHEDRAL

Color: iron-black to dark steel-gray. Opaque. Luster: metallic, sometimes dull, earthy. Form: foliated, scaly, columnar, radiating, or compact earthy masses; rarely in six-sided tabular crystals. Feel greasy. H = 1–2. Sp. gr. = 2.09–2.23.

Rhombohedral: c = 1.386, p_0 = 0.924. Cleavage: basal, perfect.

Composition: C, often impure from the presence of clay.[26]

LOCALITIES: *Berks County:* Antietam Reservoir, Boyertown, Gabelsville, Jones mine, Longswamp, Siesshotzville; *Bucks County:* Holland, Johnson's mine, Paxon's quarry, and Vanartsdalen's quarry; *Chester County:* Avondale, Byers, Chester Springs, Coventryville, Charlestown, French Creek mines, Kimberton, Pughtown, Pusey's quarries, Uwchlan, West Nantmeal; *Lancaster County:* Providence township; *Lehigh County:* Macungie; *Montgomery County:* Conshohocken, Henderson, King of Prussia, Lafayette, Marble Hall, West Conshohocken; *Northampton County:* Chestnut Hill; *Philadelphia:* Wissahickon Station; *York County:* Hellam, and New Holland.

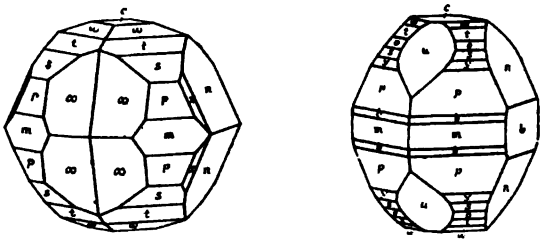
SULFUR

S — ORTHORHOMBIC

Color: straw-yellow to greenish-yellow or yellowish-brown. Streak: white. Transparent to translucent. Luster: resinous. Form: pyramidal to tabular crystals; drusy coatings and incrustations. Brittle. H = 1.5–2.5. Sp. gr. = 2.05–2.09.

Crystallography: Orthorhombic. a:b:c = 0.8138:1:1.9055

$p_0:q_0:r_0$ = 2.3414:1.9055:1



1 2

Figs. 1–2. Sulfur, Wheatley mines (*Buss*).

[26] An old analysis exists of graphite from Johnson's mine near Trevose, Bucks County, by (J. Vanuxem, Acad. Nat. Sci. Phila., V, 23, 1825); C 94.40, SiO_2 2.60, FeO and MnO 1.40, H_2O 0.60, sum 99.00

Forms: *a* (100), *b* (010), *c* (001); *m* (110), *r* (210), *n* (011), *u* (103), *e* (101); *w* (117), *t* (115), *o* (114), *s* (113), *y* (112), *p* (111), *δ* (221), *α* (313), *r* (311), *q* (131). Wheatley mines (Fletcher, 1880, 187; Busz, 1889, 620). Cleavage: *c* imperfect. Fracture: conchoidal, even.

LOCALITIES: *Carbon County:* Burning Mine, Summit Hill; *Chester County:* Wheatley mines, (pale yellowish-green pyramidal crystals with galena and anglesite); *Montgomery County:* Barren Hill, and King of Prussia.

BISMUTH

Bi RHOMBOHEDRAL

Color and streak: silver-white. Luster: metallic. Opaque. Form: foliated and granular masses. H = 2.5. Sp. gr. = 9.70–9.83.

LOCALITY: a specimen in the Rand Collection at Bryn Mawr College is labeled "West Sadsbury, Chester County."

GOLD

Au ISOMETRIC

Color: yellow. Opaque. Luster: metallic. Form: flattened grains, scales, and irregular crystals. Malleable and ductile. H = 2.5–3. Sp. gr. 15.6–19.3. Fracture: hackly.

Composition: Au, usually alloyed with Ag.

LOCALITIES: *Berks County:* Reading; *Bucks County:* New Galena, Rock Hill, and Yardley; *Lancaster County:* Gap mine; *Lebanon County:* Cornwall; *Montgomery County:* Delaware River gravels at Bridesburg, Hendricks Station, and in Franconia township; *Philadelphia:* disseminated in the clays beneath the southern part of the city.

SILVER

Ag ISOMETRIC

Color: white, often tarnished. Opaque. Luster: metallic. Form: plates, scales, wires, distorted crystals. Ductile, malleable. H = 2.5–3. Sp. gr. = 10.1–11.1. Fracture: hackly.

Composition: Ag, with Au.

LOCALITIES: *Berks County:* Cushion Mountain, and Reading; *Chester County:* Wheatley mines; *Montgomery County:* Perkiomen mine.

COPPER

Cu ISOMETRIC

Color: red. Opaque. Luster: metallic. Form: filiform and arborescent aggregates of crystals, often distorted. Ductile and malleable. H = 2.5–3. Sp. gr. = 8.8–8.9. Fracture: hackly.

Crystallography: Isometric. Common forms: *a* (100), *d* (110), *o* (111), *h* (410); twin-plane *o* (111).

LOCALITIES: *Adams County:* Gettysburg, and Hamiltonban; *Berks County:* Jones Mine; *Chester County:* Wheatley mine; *Lebanon County:* Cornwall; *Lehigh County:* Ironton; *Montgomery County:* Ecton mine, Perkiomen mine, and Sumneytown.

TIN

Sn TETRAGONAL

Color: white. Luster: metallic. Opaque. Form: rounded grains. H = 2. Sp. gr. = 7.178.

LOCALITY: *Montgomery County:* Franconia township, in gravels with gold. It is quite possible that the tin came from the pan used in panning the gold.

PLATINUM

Pt ISOMETRIC

Color: steel-gray. Luster: metallic. Opaque. Form: grains and scales. H = 4.5–5. Sp. gr. = 14–19.

LOCALITIES: platinum has been reported as occurring in black shales near Congo, Montgomery County; and near Shamokin, Schuylkill County.

SULFIDES

STIBNITE	Sb_2S_3	Orthorhombic
BISMUTHINITE	Bi_2S_3	Orthorhombic
MOLYBDENITE	MoS_2	Rhombohedral?
GALENA	PbS	Isometric
CHALCOCITE	Cu_2S	Orthorhombic
SPHALERITE	ZnS	Isometric
PENTLANDITE	(Fe,Ni)S	Isometric
COVELLITE	CuS	Rhombohedral
GREENOCKITE	CdS	Hexagonal
MILLERITE	NiS	Rhombohedral
PYRRHOTITE	Fe_nS_{n+1}	Orthorhombic
BORNITE	Cu_5FeS_4	Isometric
CHALCOPYRITE	$CuFeS_2$	Tetragonal
PYRITE	FeS_2	Isometric
GERSDORFFITE	NiAsS	Isometric
MARCASITE	FeS_2	Orthorhombic
LÖLLINGITE	$FeAs_2$	Orthorhombic
ARSENOPYRITE	FeAsS	Orthorhombic

STIBNITE

Sb_2S_3 ORTHORHOMBIC

Color and streak: lead-gray. Luster: metallic, splendent. Opaque. Form: striated prismatic crystals, often curved; in aggregates of acicular crystals. H = 2. Sp. gr. = 4.52–4.62.

Composition: Sb_2S_3; Sb 71.4, S 28.6, = 100.

LOCALITY: *Berks County:* Fritz Island, with zeolites.

BISMUTHINITE

Bi_2S_3 ORTHORHOMBIC

Color: lead-gray to tin-white, often with a yellow or iridescent tarnish. Opaque. Luster: metallic. Form: acicular crystals, or fibrous masses. H = 2. Somewhat sectile. Sp. gr. 6.4–6.5. Cleavage: *b* perfect; *a*, *m*, imperfect.

Composition: Bi_2S_3. Bi 81.2, S 18.8, = 100.

LOCALITIES: *Delaware County:* Avondale; *Philadelphia:* opposite the old Fairmount Water Works, in Fairmount Park.

MOLYBDENITE

MoS_2 HEXAGONAL

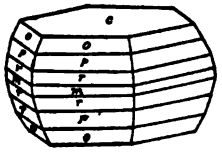


Fig. 3. Molybdenite, Frankford, Philadelphia (*Brown*).

Color: lead-gray. Streak: bluish-gray on paper, slightly greenish on porcelain. Opaque. Luster: metallic. Form: foliated masses or scales; tabular crystals. Eminent basal cleavage. Laminae very flexible. Feel greasy. Sectile. H = 1–1.5. Sp. gr. = 4.7–4.8.

Crystallography: Hexagonal; c = 1.54; p_0 = 1.0267. Forms: *c* (0001), *o* (10$\bar{1}$1), *p* (20$\bar{2}$1), *q* (30$\bar{3}$1), *m* (10$\bar{1}$0); Frankford, Philadelphia (Brown, 1896, 210).

Composition: MoS_2; Mo 60, S 40, = 100.

Analyses: A. Upland, Delaware County. Seybert, 1822, 320. B. Valentine Hartman's mine, 1 mile west of Spies Church, Alsace Township, Berks County. Wetherill, 1853, 345. C. The same, after deducting impurities.

	A	B	C
Mo	59.42	55.73	59.33
S	39.68	38.20	40.67
SiO_2	——	2.28	——
Fe_2O_3	——	3.50	——
H_2O	——	0.29	——
	99.10	100.00	100.00

LOCALITIES: *Berks County:* Antietam Reservoir, Flint Hill?, and Valentine Hartman's mine in Alsace township; *Bucks County:* Finney's Quarry; *Chester County:* French Creek mines, Brandywine Battlefield, and Sylmar, *Delaware County:* Avondale, Drexel's quarry, Peter Green's farm near Upland Station, Franklin Paper Mill, Morton, and Ward's quarry; *Lehigh County:* Vera Cruz; *Montgomery County:* Paper Mills Station; *Northampton County:* Chestnut Hill; *Philadelphia:* Fairmount Park, opposite the Fairmount Water Works, Frankford (in tabular crystals up to 10 × 5 cm.), Penn Street quarries, Wayne quarries, and the Rittenhouse quarry in Germantown.

GALENA

PbS_2 ISOMETRIC

Color and streak: lead-gray. Opaque. Luster: metallic. Form: cubic crystals, coarse to fine granular, occasionally fibrous. H = 2.5–2.75. Sp. gr. 7.4–7.6.

Crystallography: Isometric. Common forms: *a* (100), *d* (110), and *o* (111). Cleavage: cubic, less often octahedral.

Composition: PbS. Pb 86.6, S 13.4, = 100. Usually contains some Ag.

LOCALITIES: *Allegheny County:* Pittsburgh; *Blair County:* Keystone Zinc mine near Birmingham; *Bradford County:* in the Carboniferous sandstones; *Berks County:* Fritz Island; *Bucks County:* New Galena; *Chester County:* Charlestown mine, Morris mine, and Wheatley mines (argentiferous); *Columbia County:* Espy mine; *Fayette County:* Victoria; *Huntingdon County:* McConnellstown; *Lancaster County:* Bamford, Pequa (argentiferous, with a distinct octahedral and cubic cleavage), Salisbury township, and Marietta (in goethite geodes); *Lycoming County:* Bald Eagle Valley, and Roaring Branch of Lycoming Creek; *Montgomery County:* Ecton mine, Perkiomen mine, and Sumneytown; *Northampton County:* Chestnut Hill; *Northumberland County:* Sunbury; *Philadelphia:* Falls of Schuylkill; *Pike County:* Guymard; *Schuylkill County:* Pottsville; *Sullivan County:* Forkville; *York County:* Hellam and York Valley.

CHALCOCITE

Cu_2S ORTHORHOMBIC

Color and streak: blackish lead-gray, often tarnished blue. Opaque, dull. Luster: metallic. Form: compact, massive or granular; tabular crystals. Brittle. H = 2.5–3. Sp. gr. 5.5–5.8.

Composition: Cu_2S; Cu 79.8, S 20.2, = 100.

LOCALITIES: *Bradford County:* Carpenter mine near New Albany; *Berks County:* Fritz Island, and Jones mine; *Bucks County:* Finney's quarry, and Uhlertown; *Chester County:* Wheatley mines; *Lancaster County:* Gap mines; Glenwood Station, and Wood's chrome mine; *Lebanon County:* Cornwall; *Lehigh County:* South Mountain; *Lycoming County:* Muncy, and Roaring Branch of Lycoming Creek; *Montgomery County:* Ecton mine, and Sumneytown; *Northampton County:* Chestnut Hill; *Philadelphia:* Frankford; *Sullivan County:* Muncy Valley.

SPHALERITE

ZnS ISOMETRIC (Tetrahedral)

Color: yellow, green, brown, black, or gray. Streak: brownish, light yellow, or white. Transparent to translucent. Luster: resinous to adamantine. Form: tetrahedral crystals; massive, cleavable, granular or compact. Brittle. H = 3.5–4. Sp. gr. 3.9–4.1.

Crystallography: Isometric, tetrahedral. Common forms: *a* (100), *d* (110), *o* (111), *o'* ($1\bar{1}1$), *m* (311). Twin-plane *o*, composition face usually parallel to *o*. Crystals are frequently complex and distorted. Cleavage: dodecahedral.

Composition: ZnS; Zn 67, S 33, = 100; usually with Fe. Marmatite: ferriferous, containing over 10% Fe, dark brown to black. Sp. gr. 3.9–4.05.

Analyses: A. Cornwall, Lebanon County. Greenish-brown, crystals, sp. gr. 4.033. Genth, 1882, 401. B. Phoenixville, Chester County. Brown. Smith, 1855, 250. C. Ecton mine, Montgomery County. Genth, 1875, 15, analysis by Harry W. Jayne. D. Friedensville, Lehigh County. Grayish-white, cryptocrystalline. Genth, 1875, 15, analysis by Jayne.

	A	B	C	D
Zn	66.47	64.39	65.04	66.72
Cd	——	0.98	——	——
Pb	——	0.78	——	——
Fe	0.38	——	2.17	0.49
Co	0.34	——	——	——
Cu	——	0.32	——	——
S	32.69	33.82	33.45	33.13
Quartz	——	——	0.80	0.75
	99.88	100.29	101.46	101.09

LOCALITIES: *Blair County:* Keystone zinc mine near Birmingham; *Bucks County:* New Galena; *Chester County:* French Creek mines (marmatite, black crystals), Jug Hollow mine (pale yellow crystals), Phoenixville Tunnel, and the Wheatley mines (brown, modified and twinned dodecahedra); *Columbia County:* Espy mine; *Fayette County:* Victoria; *Lancaster County:* Bamford and East Petersburg; *Lebanon County:* Cornwall; *Lehigh County:* Friedensville (grayish cryptocrystalline masses); *Lackawanna County:* Scranton; *Lycoming County:* Roaring Branch of Lycoming Creek; *Montgomery County:* Ecton mine, and Perkiomen mine; *Northumberland County:* Sunbury; *Philadelphia:* Falls of Schuylkill (brown, radiating acicular crystals, perhaps paramorphous after wurtzite); *Pike County:* Guymard, and Poxono Island; *York County:* Emigsville, Hellam, York Valley, and York.

PENTLANDITE

(Fe, Ni)S ISOMETRIC

Color: light bronze-yellow. Opaque. Luster: metallic. Form; massive, granular. Brittle. H = 3.5–4. Sp. gr. 4.60. Non-magnetic.

Composition: (Fe, Ni)S. Fe 42, Ni 22, S 36, = 100.

4 5

Fig. 4. Very deeply etched pyrrhotite with light veins of pentlandite, Gap mine, Lancaster County, × 50. (*Campbell* and *Knight.*)

Fig. 5. Very deeply etched pyrrhotite between the grains of which occur a mass of chalcopyrite and pentlandite and a silicate, Gap mine, Lancaster County, × 50. (*Campbell* and *Knight.*)

Analyses: Pentlandite; Gap Mine, Lancaster County; Genth, 1875, 13–14, analyzed by Henry Pemberton, Jr. A. Analysis of non-magnetic portion of pyrrhotite, or about 6% of the latter. B. Recalculated analysis. C. Theoretical composition corresponding to 3NiS.2FeS.

A		B		C	
Fe	22.22	FeS	26.40	Fe	24.94
Ni	25.73	NiS	39.96	Ni	39.42
Mg	2.73	FeO	6.00	S	35.64
S	23.56	MgO	2.73		
Hornblende	24.81	Insoluble	24.81		
	99.05		99.90		100.00

LOCALITY: *Lancaster County:* Gap nickel mine.

COVELLITE

CuS — RHOMBOHEDRAL (Trapezohedral)

Color: indigo-blue. Streak: lead-gray to black, shining. Opaque. Luster: submetallic, subresinous or dull. Form: massive, incrusting; very rarely crystallized. H = 1.5–2. Sp. gr. 4.59.

Composition: CuS; Cu 66.4, S 33.6, = 100.

LOCALITIES: *Chester County:* Wheatley mines; *Lebanon County:* Cornwall; *Philadelphia:* O'Neill's quarry.

GREENOCKITE
(Xanthochroite)

CdS — AMORPHOUS

Color: honey- to orange-yellow. Translucent. Luster: adamantine to resinous. Form: coatings, usually on sphalerite. H = 3–3.5. Sp. gr. 4.9–5.

Composition: Cds. Cd 77.7, S 22.3, = 100.

LOCALITIES: *Lehigh County:* Friedensville, yellow or orange colored coatings on sphalerite; *Montgomery County:* Perkiomen mine: *York County:* York.

MILLERITE

NiS — RHOMBOHEDRAL

Color: brass-yellow, often with a gray iridescent tarnish. Streak: greenish-black. Opaque. Luster: metallic. Form: thin coatings of a radiated fibrous structure; slender capillary crystals. Brittle. H = 3–3.5. Sp. gr. 5.3–5.65.

Composition: NiS. Ni 64.6, S 35.3, = 100.

Analyses: Gap Mine, Lancaster County. Brass yellow, radiating, frequently tarnished to chalcocite, Genth, 1862, 195. A. Millerite. B. Millerite partially altered to chalcocite.

	A	B
Ni	63.08	59.96
Co	0.58	
Fe	0.40	1.32
Cu	0.87	4.63
S	35.14	33.60
Gangue	0.28	0.54
	100.35	100.05

LOCALITIES: *Lancaster County:* Gap nickel mine, pale yellow radiating aggregates; Wood's chrome mine, in kammererite; *Lackawanna County:* Scranton? *Lycoming County:* Roaring Branch of Lycoming Creek? *Montgomery County:* Ecton mine? and Rose's quarry; *Philadelphia:* Prince's quarry, capillary crystals in dolomite.

PYRRHOTITE

Fe_nS_{n+1} — ORTHORHOMBIC (Pseudohexagonal)

Color: bronze-yellow to copper-red, tarnished. Streak: dark grayish-black. Opaque. Luster: metallic. Form: massive, granular. Brittle. H = 3.5–4.5. Sp. gr. 4.58–4.64. Magnetic.

Composition: Fe_nS_{n+1}. Fe_7S_8 = Fe 60.4, S. 39.6, = 100. $Fe_{11}S_{12}$ = Fe 61.6, S 38.4, = 100.

Analyses: Gap Mine, Lancaster County (see also Pentlandite). A. Rammelsberg, 1864, 361. B. Boyé, 1852, 219. Analysis of a mixture.

	A	B
Fe	55.82	41.34
Ni, Co	5.59	4.55
Cu	——	1.30
Pb	——	0.27
S	(38.59)	24.84
Silicates	——	25.46
Alumina	——	1.70
	100.00	99.46

LOCALITIES: *Berks County:* Antietam Reservoir, Boyertown, Gottschall's mine in Alsace (slightly nickeliferous), and the Raudenbush mine; *Bucks County:* Finney's quarry, Langhorne, Paxon's quarry, and Vanartsdalen's quarry; *Chester County:* French Creek mines, Byers, and Jackson's quarry (New Garden); *Lancaster County:* Gap nickel mine, and Quarryville; *Montgomery County:* Paper Mills Station; *Philadelphia:* Fairmount Park, and Prince's quarry.

BORNITE

Cu_5FeS_4 ISOMETRIC

Color: copper-red to pinchbeck-brown, usually with an iridescent tarnish. Streak: pale grayish-black. Form: massive, granular or compact. Fracture: conchoidal, uneven. H = 3, Brittle. Sp. gr. 5.06–5.08 for the purest material.

Composition: Cu_5FeS_4. Cu 63.33, Fe 11.12, S 25.55, = 100. Analyses and metallographic examination usually show admixtures of chalcopyrite, etc., which cause variations from the theoretical composition.

LOCALITIES: *Adams County:* Gettysburg; *Berks County:* Fritz Island, Jones mine; *Bucks County:* Finney's quarry; New Galena; *Chester County:* French Creek mines, Warwick mines; *Lycoming County:* Muncy; *Montgomery County:* Ecton mine, Hendricks Station, Perkiomen mine, Schwenksville, Sumneytown, and Rose's quarry; *Philadelphia:* Germantown, Frankford, O'Neill's quarry, Prince's quarry, and Rittenhouse quarry; *Sullivan County:* Muncy Valley.

CHALCOPYRITE

$CuFeS_2$ TETRAGONAL (Sphenoidal)

Color: brass-yellow, often tarnished purple and iridescent. Streak: greenish-black. Opaque. Luster: metallic. Form: tetrahedral crystals, rarely prismatic; massive, compact. Brittle. H = 3.5–4. Sp. gr. 4.1–4.3.

Crystallography: Tetragonal, sphenoidal. c, p_0 = 1.3933.

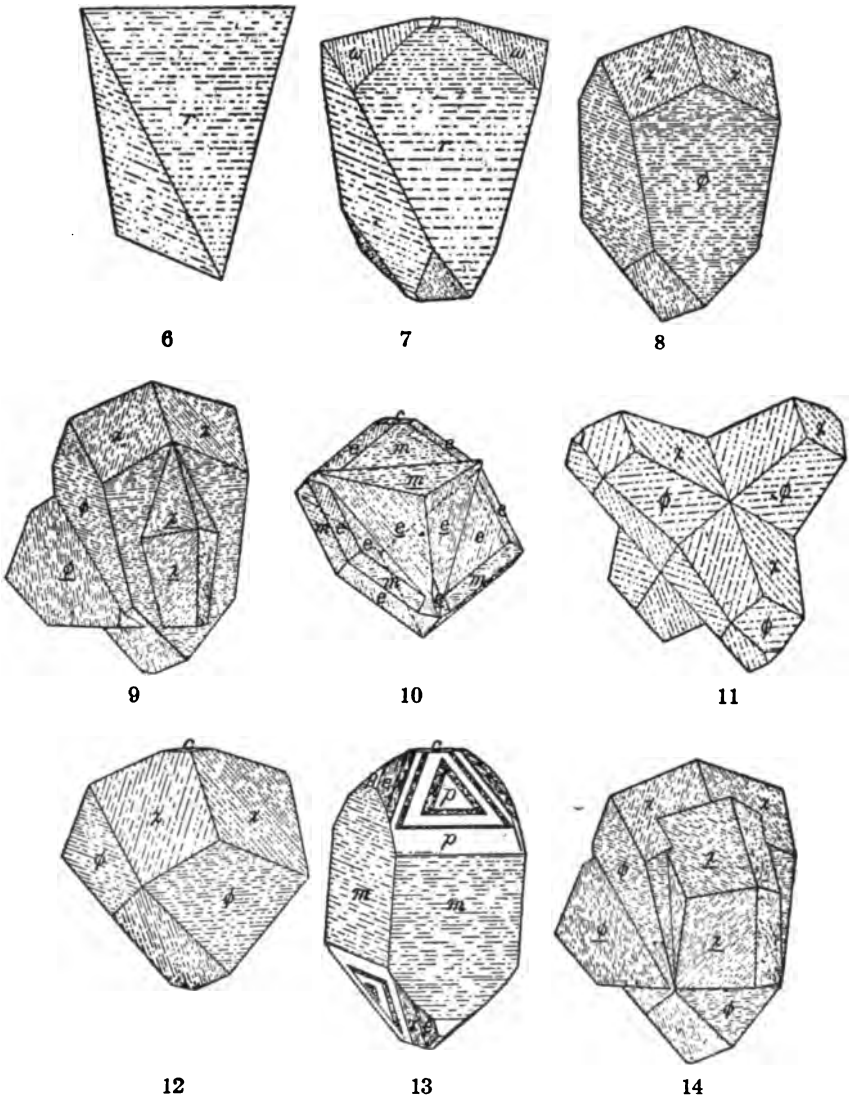
Forms: r (332), ω (576)?, c (001), p (111), p' ($1\bar{1}1$), m (110), e (101), and the doubtful forms ϕ (722) and χ (122) probably due to oscillation of a prism and second pyramid respectively. Crystals are frequently distorted by striations parallel to the intersections of faces with the + and — unit sphenoids. Twins common; twin-plane p (111), composition face p, also $\perp p$. French Creek mines, (Penfield, 1890, 207).

Composition: $CuFeS_2$. Cu 34.5, Fe 30.5, S 35, = 100.

Analysis: Wheatley mine, Chester County. Smith, 1855, 249.

Cu	32.85
Fe	29.93
Pb	0.35
S	36.10
	99.23

LOCALITIES: *Berks County:* Boyertown, Fritz Island, and Jones mines; *Bucks County:* Buckmanville, Bursonville, Finney's quarry, Holland, New Galena, and Sellersville; *Chester County:* French Creek mines, Jug Hollow mine, Morris mine, Warwick mines, and Wheatley mines; *Delaware County:* Avondale, Peter Green's farm near Upland, Strath Haven Inn; *Lancaster County:* Gap mine; *Lebanon County:* Cornwall; *Lycoming County:* Roaring Branch of Lycoming



Figs. 6–14. Chalcopyrite, French Creek mines, Chester County (*Penfield*).

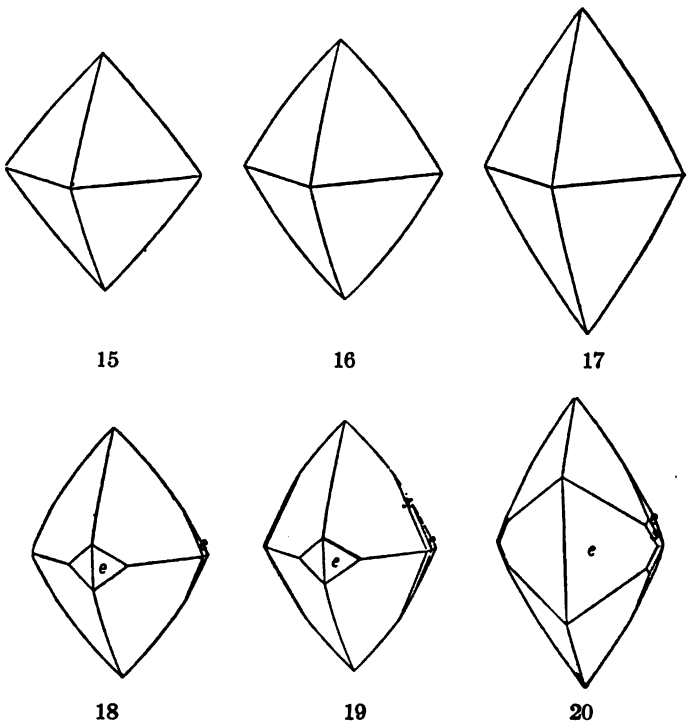
Creek; *Montgomery County:* Congo, Ecton mine, Gladwyne, Hendricks Station, Marble Hall, Mogeetown, Ogontz, Paper Mills Station, Pennsbury Station, Perkiomen mine, Port Kennedy, Shainline, Shannonville copper mine, Sumneytown; *Northampton County:* Chestnut Hill; *Philadelphia:* Fairmount Park, Frankford, Germantown, Logan, O'Neill's quarry, Prince's quarry, and Wissahickon Valley; *York County:* Emigsville, New Holland, Spring Grove, Wrightsville. York, and York Valley.

PYRITE

FeS_2 ISOMETRIC (Pyritohedral)

Color: pale brass-yellow. Streak: greenish or brownish-black. Opaque. Luster: metallic, splendent. Form: cubic, pyritohedral or octahedral cystals; massive, granular. Brittle. H = 6–6.5. Sp. gr. 4.95–5.10.

Crystallography: Isometric, pyritohedral. Common forms: *a* (100), *d* (110), *o* (111), *e* (210), *r*(332), *s*(321). Travis, (1906, 131) described the following forms from Cornwall, Lebanon County; *a* (100), *o* (111), *e* (210), *q* (331), (11.11.4), (552), (773), *p* (221), (774), (553), *r* (332), (443), (554), (665), *Z* (531), *s* (321), (753), (432), *i* (211), (14.11.8), *t* (421), (13.7.3), (952), (14.9.3), (542), (744), (11.8.5), (15.11.7), (876), (12.11.10). Abnormally developed crystals with tetragonal or orthorhombic symmetry (probably due to vicinal development) were described from the French Creek mines by Penfield, (1889, 209). The forms exhibited were *r* (332), *e* (210), s′ (231) and *x* (6.12.7); *r* being regarded as an abnormal trigonal trisoctahedron; *x* has only 8 faces instead of 24. Penfield notes the occurrence of the rare combination of *a* (100), and *π* (420) at this locality. Combinations of *a* (100), *e* (210), *n* (211), *w* (481), *t* (241), and H_1 (341) are not uncommon (Wherry 1920, 116). Nicol (1904, 93) described a spinel twin, from the French Creek mines.



15 16 17

18 19 20

Figs. 15–20. Pyrite, French Creek mines, Chester County (*Penfield*).

Composition: FeS_2. Fe 46.6, S 53.4, = 100. Pyrite frequently contains Ni, Co, Th, Cu, Ag, and As.

Analyses: A. French Creek mines, Chester County. Genth, 1890, 114, analysis by Aron Hamburger. B. Cornwall, Lebanon County; cupriferous, Dana, 1854, 55, analysis by J. C. Booth. Probably an impure specimen. A cobaltiferous pyrite from Cornwall gave Blake, 2% Co (Dana, 1868, 63). A nickeliferous pyrite from Cornwall, occurring in granular or porous masses gave Genth 4.30 and 4.47% Ni, (Genth, 1875, 20).

	A	B
Fe	44.24	44.47
Ni	0.18	——
Co	1.75	——
Cu	0.05	2.39
As	0.20	——
S	54.08	53.37
	100.50	100.23

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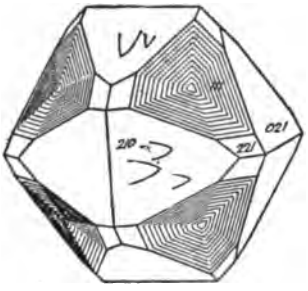

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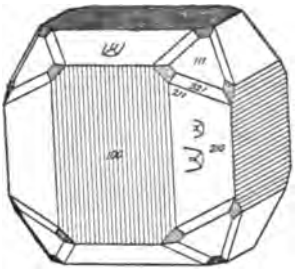

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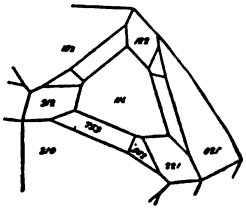

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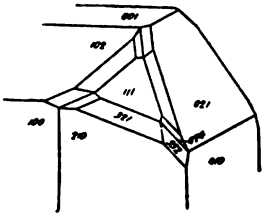

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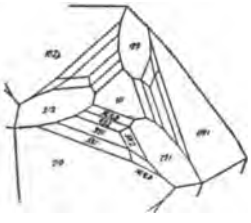

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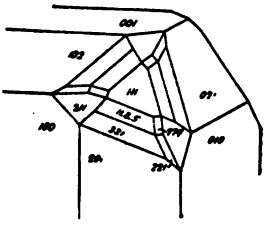

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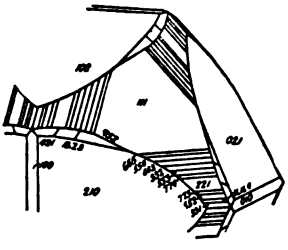

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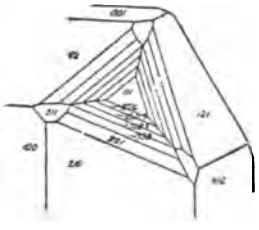


28

Figs. 21–28. Pyrite, Cornwall, Lebanon County (*Travis*).

LOCALITIES: *Adams County:* South Mountain; *Blair County:* Keystone zinc mine near Birmingham; *Berks County:* Bernville, Boyertown, Center township, Fritz Island, Jones mine, Ruth mine, Siessholtzville, Virginville, Windsor township, and Wheatfield mines; *Bucks County:* Finney's quarry, Keelersville, New Galena, Paxon's quarry, Vanartsdalen's quarry, and Wrightstown; *Chester County:* Avondale, Bailey's farm (East Marlboro), Bailey's quarry (West Marlboro), Chester Springs, Corundum Hill (Newlin), Doe Run quarries, Embreeville, French Creek mines, Hopewell mines, Lyndell, Phoenixville Tunnel, Poorhouse quarry, Pusey's quarries; Unionville, Warwick mines, and Wheatley mines; *Dauphin County:* Hummelstown; *Delaware County:* Avondale, Black Horse, Burk's quarry, Cream Valley, Custer's farm (Darby), Darby, Franklin Paper Mill, Peter Green's farm near Upland, Leiperville, Lenni, Morton, Moore, Mullen's quarries; *Fayette County:* Dunbar; *Lancaster County:* Boice farm (Texas), Gap mine, and Lancaster; *Lebanon County:* Cornwall; *Lehigh County:* Breinigsville, Friedensville, and Macungie; *Lycoming County:* Roaring Branch of Lycoming Creek; *Montgomery County:* Ecton mine, Gladwyne, Fort Washington, Hendricks Station, Huntingdon Valley Station, King of Prussia, Marble Hall, Ogontz, Paper Mills Station, Pennsbury Station, Perkiomen mine, West Conshohocken; *Northampton County:* Chestnut Hill; *Philadelphia:* Fairmount Park, Falls of Schuylkill, Frankford, Germantown, Hestonville, Logan, Overbrook, Prince's quarry, Rittenhouse quarry, Wingohocking Creek Valley; *Schuylkill County:* Pottsville, Raven Run mine; *Westmoreland County:* Irwin; *York County:* Dillsburg, Emigsville, Hellam, New Holland, Spring Grove, Thomasville, Wrightsville, and York.

GERSDORFFITE

NiAsS — ISOMETRIC (Pyritohedral)

Color: silver-white to steel-gray. Streak grayish-black. Luster metallic. Opaque. Form: cubic crystals; cleavage: cubic, perfect. Brittle. H = 5.5. Sp. gr. 5.6–6.2.

Composition: NiAsS, Ni 35.4, As 45.3, S 19.3, = 100. Fe and Co replace Ni.

LOCALITY: *Chester County:* Wheatley mines, small crystals with quartz, galena, and sphalerite.

MARCASITE

FeS_2 — ORTHORHOMBIC

Color: pale bronze-yellow. Streak grayish or brownish-black. Luster: metallic. Opaque. Form: tabular crystals, stalactites with radiating structure, globular or reniform aggregates. H = 6–6.5. Sp. gr. 4.85–4.90.

Composition: FeS_2, Fe 46.6, S 53.4, = 100.

LOCALITIES: *Berks County:* Leesport; *Lancaster County:* Gap nickel mine; *Montgomery County:* Ecton mine, and Perkiomen mine; *Philadelphia:* Logan. Casts of large crystals occur at Morgan Station, Delaware County.

LÖLLINGITE

$FeAs_2$ — ORTHORHOMBIC

Color: silver-white to steel-gray. Streak grayish-black. Luster metallic. Opaque. H = 5–5.5. Sp. gr. 7.

Composition: $FeAs_2$, Fe 27.2, As 72.8.

LOCALITY: a crystal weighing several ounces was reported to have been found in Bedford County.[27]

ARSENOPYRITE

FeAsS — ORTHORHOMBIC

Color: silver-white. Streak dark grayish-black. Luster metallic. Opaque. Form: prismatic crystals, columnar or granular masses. H = 5.5–6. Sp. gr. 5.9–6.2.

Composition: FeAsS, Fe 34.3, As 46.0, S 19.7, = 100.

LOCALITIES: *Berks County:* Gickerville; *Delaware County:* Brandywine Summit? *Montgomery County:* Ecton mine, Perkiomen mine, and West Conshohocken?

[27] The specimen was described by Shepard (1828, 183) as a meteoric iron. Genth, (1875, 6) called it spiegeleisen. Shepard's analysis, undoubtedly erroneous, follows, Fe 97.44, As 1.56, C 0.40, loss 0.60, = 100.

SULFOSALTS

BOURNONITE	$3(Cu_2,Pb)S.Sb_2S_3$	Orthorhombic
TETRAHEDRITE	$4Cu_2S.Sb_2S_3$	Isometric
TENNANTITE	$4Cu_2S.As_2S_3$	Isometric

BOURNONITE

$3(Cu_2,Pb)S.Sb_2S_3$ ORTHORHOMBIC

Color and streak: steel-gray to iron-black. Luster metallic, brilliant. Opaque. Form: short prismatic crystals, granular masses. H = 2.5–3. Sp. gr. 5.7–5.9.

Composition: with Cu_2: Pb = 1:2; Cu 13.0, Pb 42.5, Sb 24.7, S 19.8, = 100.

LOCALITY: *Chester County:* Wheatley mines?

TETRAHEDRITE

$4Cu_2S.Sb_2S_3$ ISOMETRIC (Tetrahedral)

Color: flint-gray to iron-black. Luster metallic. Opaque. Form: tetrahedral crystals, also granular. Brittle. H = 3–4.5. Sp. gr. 4.4–5.1

Composition: Cu 52.1, Sb 24.8, S 32.1, = 100.

LOCALITIES: *Adams County:* Gettysburg; *Lancaster County:* Bamford?

TENNANTITE

$4Cu_2S.As_2S_3$ ISOMETRIC (Tetrahedral)

Color: flint-gray to iron-black. Opaque. Luster: metallic. Form: massive, granular, compact; tetrahedral crystals. Brittle. H = 3–4.5. Sp. gr. 4.37–4.49.

Composition: Cu 57.5, As 17, S 25.5, = 100.

LOCALITY: *Lancaster County:* Bamford.

HALIDES

SAL-AMMONIAC	NH_4Cl	Isometric
FLUORITE	CaF_2	Isometric
MENDIPITE	$Pb_2O_2Cl_2$	Orthorhombic

SAL-AMMONIAC

NH_4Cl ISOMETRIC

Color: white or yellowish. Transparent to translucent. Luster vitreous. Form: efflorescent crusts. Brittle. H = 1.5–2. Sp. gr. 1.528.

Composition: NH_4Cl; NH_4 33.7, Cl 66.3, = 100.

LOCALITY: *Carbon County:* Burning Mine at Summit Hill.

FLUORITE

CaF_2 ISOMETRIC

Colorless, white, yellow, green, blue. Streak: white. Transparent to subtranslucent. Sometimes shows a bluish fluorescence. Luster: vitreous, splendent. Form: cubic crystals; massive, compact. Brittle. H = 4. Sp. gr. 3.01–3.25.

Crystallography: Isometric. Common forms: *a* (100), *d* (110), *o* (111), *e* (210), *h* (410), and *t* (421). Twins common, twin-plane *o* (111), forming penetration twins. Cleavage: octahedral, perfect.

Composition: CaF_2. Ca 51.1, F 48.9, = 100.

Analyses: A. Kleckner's limestone quarries, Ballietsville, Lehigh County. Purple, imperfect octahedrons. E. F. Smith, Am. Chem. J., 5, 272, 1883. B. Kleckner's limestone quarry, green variety, Smith, 1. c. C. Wheatley mine, Chester County. Colorless crystals. J. Lawrence Smith, 1855, 251. D. York, Pa. Light to dark purple. Ehrenfeld, 1890, 281.

	A	B	C	D
Ca	50.87	50.91	50.81	48.76
Fe_2O_3	tr.	tr.	——	——
F	49.20	49.00	48.29	51.24
$Ca_3(PO_4)_2$	——	——	tr.	——
	100.07	99.91	99.10	100.00
Sp. gr	3.17–3.14		3.15	3.13

LOCALITIES: *Berks County:* Brook's quarry, De Turk's quarries, east of Poplar Neck, Fritz Island, Fritztown, Leinbach's Hill, and Wheatfield mines; *Bucks County:* Bycot; *Chester County:* Edward's quarry (Newlin), Howellville, Wheatley mines; *Cumberland County:* Pine Grove; *Franklin County:* Lancaster Station; *Lancaster County:* Ephrata, Lancaster, Millersville *Lebanon County:* Cornwall; *Lehigh County:* Emaus, Omrod; *Lycoming County:* Roaring Branch of Lycoming Creek; *Mifflin County:* opposite Mt. Union; *Montgomery County:* Ecton mine, Flourtown, Marble Hall, Mogeetown, and Schwenksville; *Northampton County:* Chestnut Hill; *Philadelphia:* Cobb's Creek, Fairmount Park, Frankford, Holmesburg, and Wissahickon Valley; *Pike County:* Bushkill; *York County:* Hellam, Spring Grove, Wrightsville, York Valley.

MENDIPITE

$Pb_3O_2Cl_2$ ORTHORHOMBIC

Color: white, or yellowish. Opaque. Luster: pearly. Form: fibrous or columnar masses; cleavage: perfect. H = 2.5–3. Sp. gr. 7.

Composition: Pb 95.8, O 4.4, Cl 9.8 = 100.

LOCALITY: *Chester County:* Wheatley mines?

OXIDES

QUARTZ; CHALCEDONY	SiO_2	Rhombohedral
OPAL	$SiO_2.nH_2O$	Amorphous
CUPRITE	Cu_2O	Isometric
MELACONITE	CuO	Amorphous?
CORUNDUM	Al_2O_3	Rhombohedral
HEMATITE	Fe_2O_3	Rhombohedral
ILMENITE	$FeTiO_3$	Rhombohedral
SPINEL	$MgAl_2O_4$	Isometric
GAHNITE	$ZnAl_2O_4$	Isometric
MAGNETITE	$FeFe_2O_4$	Isometric
CHROMITE	$FeCr_2O_4$	Isometric
HAUSMANNITE	$MnMn_2O_4$	Tetragonal
CREDNERITE	$Cu_2Mn_4O_9$	Monoclinic
BRAUNITE	$3Mn_2O_3.MnSiO_3$	Tetragonal
RUTILE	TiO_2	Tetragonal
OCTAHEDRITE	TiO_2	Tetragonal
BROOKITE	TiO_2	Orthorhombic
PYROLUSITE	MnO_2	Orthorhombic?
DIASPORE	$H_2Al_2O_4$	Orthorhombic
GOETHITE	$H_2Fe_2O_4$	Orthorhombic
LEPIDOCROCITE	$H_2Fe_2O_4$	Orthorhombic
GIBBSITE	$Al(OH)_3$	Monoclinic
BRUCITE	$Mg(OH)_2$	Rhombohedral
LIMONITE	$Fe_2O_3.H_2O.Aq$	Amorphous
PSILOMELANE, WAD	$xMnO.yMnO_2.zBaO.H_2O$	Amorphous

QUARTZ

SiO_2 RHOMBOHEDRAL
(Trapezohedral)

Colorless, yellow, red, brown, blue, black. Transparent to opaque. Luster: vitreous, sometimes greasy; splendent to nearly dull. Form: hexagonal crystals with pyramidal terminations; cryptocrystalline; massive. H = 7. Sp. gr. 2.653–2.660.

Crystallography: Rhombohedral, trapezohedral; c = 1.9051; p_0 = 1.2701. Common forms: *m* $(10\bar{1}0)$, *r* $(10\bar{1}1)$, *z* $(01\bar{1}1)$, *s* $(21\bar{1}1)$, and *x* $(51\bar{6}1)$. Habit: usually prismatic; *m* faces striated horizontally, and terminated by *r* and *z*. Frequently in radiated masses or druses. Twins: twin-axis *c*, penetration twins; twin plane $\xi(11\bar{2}2)$, contact twins.

Composition: SiO_2; Si 46.7, O 53.3, = 100.

Crystalline varieties: 1. Rock crystal: colorless or nearly so. 2. Smoky: smoky-yellow to smoky-brown, usually transparent. 3. Amethyst: clear purple or bluish-violet. 4. Citrine: yellow and pellucid. 5. Rose: red or pink, commonly massive. 6. Milky: milky-white, opaque. 7. Sagenitic: containing acicular crystals of rutile. 8. Aventurine: spangled with scales of mica, etc. 9. Ferruginous: red or yellow, due to iron oxides.

Cryptocrystalline varieties: 1. Chalcedony: white, gray, pale brown to dark brown, black, or blue. Transparent to translucent. Luster: waxy. Form: mammillary or botryoidal, stalactitic. Sp. gr. 2.6–2.64. 2. Carnelian: clear red chalcedony. 3. Chrysoprase: apple-green chalcedony. 4. Prase: dull leek-green, translucent. 5. Agate: variegated chalcedony, with colors in bands, or clouds, or impurities. Moss-agate is chalcedony with dendritic inclusions of manganese oxide. 6. Flint: gray, smoky-brown or brownish-black; luster: subvitreous, fracture: conchoidal. 7. Hornstone or chert: resembles flint, but more brittle. Includes impure flints. 8. Basanite: velvet black; flinty jasper. 9. Jasper: red, brownish, ochre-yellow; opaque.

LOCALITIES: Colorless and smoky varieties: *Adams County:* Franklin Valley, Gettysburg, Hamiltonban; *Blair County:* Bellwood; *Berks County:* Berg's farm (Albany), Blandon, Crystal Cave, Esterly, Fleetwood, Flint Hill, Friedensburg, Fritz Island, Great Valley, Green Hill, Jacksonwald, Kirbyville, Lee's farm (Oley), Leinbach's Hill, Pricetown, Reading, Union township, and Windsor; *Bucks County:* Bensalem township, Bristol township, Buckmanville, Buckingham Mountain, Falls township, Flushing, Lower Makefield township, Middletown township, New Galena, Newportville, and Woodbourne; *Center County:* Buffalo Run; *Chester County:* Avondale (crystals up to 12.5 cm. in diameter), Bailey's farm (East Marlboro), Brinton's quarry, Charlestown mine, Coatesville, Corundum Hill (drusy, green), Copesville, Devault, Diamond Rock, Doe Run quarries, East Whiteland, Edward's quarry (Newlin), Hopewell mines, Marshall's quarry (West Goshen), Mendenhall's quarry (Pennsbury), Mullen's farm (Kennett), Osborn Hill, Oxford (smoky), Parkesburg, Phoenixville tunnel, Poorhouse quarry, Pusey's quarries, Sadsburyville, Swayne's farm (in muscovite), and Toughkenamon; *Cumberland County:* Kimmel's farm (New Kingston), Carlisle; *Delaware County:* Adele (smoky and ferruginous), Avondale, Black Horse (green and ferruginous), Boothwyn (limpid, smoky and milky crystals up to 25 cm. in length, often in parallel growths), Bonsall's farm (Middletown), Brandywine Summit (yellow), Burmont (smoky crystals), Castle Rock (ferruginous and drusy), Chelsea, Gillespie's quarry, Glen Riddle, Green's farm, Gradyville (large smoky crystals), The Hunt (drusy, stalactitic), Kellyville (smoky crystals), Lansdowne (fine smoky crystals up to 18 × 23 cm.), Lenni (green and ferruginous), Moro Phillip's chrome mine (drusy), Mineral Hill (ferruginous), Leiperville (colorless and smoky crystals), Mullen's quarries, Painter's farm on Dismal Run, Radnor (drusy, stalactitic), Shaw and Esrey's quarry in Chester (amethyst and smoky crystals in parallel growths), Sharpless quarry, Smedley's quarry, Smedley's iron mine, Trainer (limpid, smoky, and milky crystals), Tyler's farm (Middletown, green and ferruginous), Upper Darby (colorless and smoky crystals), Worrall, and Yarnall's farm (Edgemont); *Fayette County:* Dunbar; *Franklin County:* "dodecahedral" crystals; *Huntingdon County:* Ray's Hill tunnel; *Lancaster County:* Adamstown, Drumore, Gap Hills, Gap mine, Kinzer, New Holland, Pequa mines, Rossmere (crystals up to 6.5 dcm.), Wood's chrome mine (drusy); *Lebanon County:* Cornwall; *Lehigh County:* Emaus (ferruginous, jasperized) Friedensville, Omrod; *Luzerne County:* Bear Creek; *Lycoming County:* Roaring Branch of Lycoming Creek; *Monroe County:* Crystal Hill, Delaware Water Gap, and Broad Mountain; *Montgomery County:* Bridgeport, Camp Hill, Congo, Conshohocken (red, aventurine), Ecton mine,

Edge Hill, Henderson, King of Prussia, Marble Hall, Mogeetown, Norristown, Ogontz, Oreland, Perkiomen mine, Roslyn Heights, Shainline, Spring Mill, Swedeland, Sumneytown, West Conshohocken; *Northampton County:* Bingen (ferruginous), Easton, Crystal Spring on Blue Mountain, Leithsville, Nazareth (colorless crystals up to 7.5 cm.), Redington (fibrous, cats-eye); *Philadelphia:* Chestnut Hill, Cobb's Creek, Fairmount Park, Frankford, Germantown, south of Lafayette, Logan (large colorless crystals), O'Neill's quarry, Overbrook (large colorless and smoky crystals), Tacony Creek, West Philadelphia, Wingohocking Creek Valley (colorless and milky crystals up to 30 × 50 cm.), Wissahickon Station, and Wissahickon Valley; *Pike County:* Pond Eddy; *Schuylkill County:* Mahanoy City, Shamokin, and Swatara; *Tioga County; York County:* Hanover, Hellam, Spring Grove, Thomasville, Wrightsville, York Valley, and York.

Amethyst: *Bedford County:* East Bedford; *Chester County:* Brinton's quarry, Charlestown township, East Caln, East Marlboro, Entrikin's farm, Glenhall, Jug Hollow mine, Lenape, Parkesburg, Pocopson, Sadsburyville; *Delaware County:* Boothwyn, Chadd's Ford, Concord township, Copple's farm (Upper Providence), Crozierville, Edgemont, Glen Mills, Henvi's quarry, Hunter's farm (Upper Providence), Marshall's farm near Dismal Run (enclosing rutile), McCall's farm (Chester township), Morgan Station, Randolph's farm, Sharpless' farm (Nether Providence), Shaw and Esrey's quarry in Chester, Wawa, and Worrall's farm (Marple and Upper Providence townships; deep purple crystals, in groups up to 6 × 25 cm.); *Lancaster County:* Mount Pleasant (Bart), Strasburg; *Philadelphia:* Falls of Schuylkill, and Tacony Creek; *York County:* New Salem.

Blue quartz: in areas of Baltimore gneiss or Pickering gneiss. *Bucks County:* Buck Ridge, Finney's quarry, Trevose, Langhorne, Morrisville, Neshaminy Falls, Paxon's quarry, and Vanartsdalen's quarry; *Chester County:* Chester Springs, and Uwchlan; *Montgomery County:* Huntingdon Valley Station, Paper Mills Station, Willow Grove, and Wyncote.

Green quartz: *Chester County:* Corundum Hill (Newlin); *Delaware County:* Blue Hill (blue and green, doubly terminated crystals, often in radiated aggregates), Black Horse, and Tyler's farm (Middletown).

Chalcedony: *Adams County:* Gettysburg; *Berks County:* Blandon, Boyertown, Cushion Mountain, Gottschall's mine, Fleetwood, Flint Hill, Friedensburg, Fritz Island, Moselem mines, Pricetown, and Wernersville; *Bucks County:* Durham; *Chester County:* Corundum Hill (Newlin), Hopewell mines, Marshall's quarry (West Goshen), Octoraro Creek, and Willistown; *Delaware County:* Castle Rock, Marple, and Radnor; *Lancaster County:* Rock Springs Run (carnelian and moss-agate), Wood's chrome mine; *Lebanon County:* Cornwall; *Montgomery County:* Conshohocken, Ecton mine, Perkiomen mine, and Spring Mill; *Northampton County:* Redington (prase, leek-green).

Flint, hornstone, and basanite. *Berks County:* Blandon, Boyertown, Friedensburg, and Kutztown; *Bucks County:* Bycot; *Montgomery County:* Barren Hill, Conshohocken, and Willow Grove; *Northampton County:* Easton; *Philadelphia:* Wissahickon Valley, and the Schuylkill River sands and gravels.

Jasper: *Berks County:* Blandon, Boyertown, Cushion Mountain, Flint Hill, Gottschall's farm (Alsace), Greenwich township, Kinsey Hill, Pricetown, Reading, Topton, and Wernersville; *Bucks County:* Durham, Woodbourne; *Chester County:* Corundum Hill (Newlin), Marshall's quarry (West Goshen); *Delaware County:* Custer's farm (Darby), The Hunt; *Lancaster County:* Rock Springs Run, and Wood's chrome mine; *Lebanon County:* Cornwall; *Northampton County:* Leithsville.

Silicified wood[28] occurs in the Triassic at the following localities: *Bucks County:* one-quarter mile southeast of Roelofs Station; one and a half miles north of Woodbourne Station; bed of Neshaminy Creek, one and a half miles west of Newtown; roadside exposures northeast of St. Leonard's Station, fields along north bank of Mill Creek near Rocksville (Holland P. O.), fields south and southeast of Holland Station, fields east of Churchville Station, fields along ridge just northwest of Center Hill and for two miles southwestward, fields one mile southwest of Spring Valley, fields one and a half miles south of Doylestown; *Montgomery County:* along Trenton Cut-off R. R., one-quarter mile east of Morganville Station, sand quarry one-half mile northwest of cross-roads at Jarrettown, sand quarry one-quarter mile east of cross-roads at Maple Glen; *Chester County:*

[28] Edgar T. Wherry, Silicified wood from the Triassic of Pennsylvania; Proc. Acad Nat. Sci. Phila., 64, 366–379, 1912.

roadside three-quarters mile northeast of cross-roads at Sheeder, fields one-quarter mile east of Coventryville; *Lancaster County:* fields two miles northwest of Churchtown, P. R. R. cut one-half mile southeast of Elizabethtown and in the fields to the east and southwest of the town; in fields three miles northeast and one mile north of Bainbridge; *Westmoreland County:* in Carboniferous rocks near Greensburg; *York County:* in fields, 2 miles south and southeast of York Haven.

OPAL

$SiO_2.nH_2O$ AMORPHOUS

Colorless, white, yellow, red, brown, green, gray, or blue. Streak: white. Luster: vitreous. Transparent to nearly opaque. Form: small reniform, stalactitic masses. H = 5.5–6.5. Sp. gr. 1.9–2.3.

Hyalite: colorless or green, transparent globular concretions.

Analysis: Cornwall, Lebanon County. Genth, 1875, 61, analysis by William P. Headden.

SiO_2	92.65
Fe_2O_3,Al_2O_3	1.57
H_2O	5.55
	99.77

LOCALITIES: *Bucks County:* Finney's quarry, and Woodbourne; *Delaware County:* Avondale, Black Horse, Drexel's quarry, Gillespie's quarry, Morton, and Springfield. *Lebanon County:* Cornwall; *Philadelphia:* Branchtown, Cobb's Creek, Fairmount Park, Frankford (white, yellow, and green hyalite, fluorescent), Germantown, Overbrook, Rittenhouse quarry, Wingohocking Creek, Wissahickon Valley.

CUPRITE

Cu_2O ISOMETRIC (Trapezohedral)

Color: cochineal-red to crimson. Subtransparent to subtranslucent. Luster: adamantine to submetallic. Form: octahedral or cubic crystals; capillary needles (chalcotrichite). H = 3.5–4. Sp. gr. 5.85–6.15.

Crystallography: Isometric, trapezohedral. Common forms: *a* (100), *o*(111), *d* (110). Commonly in octahedra or cubes, also in dodecahedra. Cubic crystals are often elongated to form acicular crystals (chalcotrichite).

Composition:[19] Cu_2O. Cu 88.8, O 11.2, = 100.

LOCALITIES: *Adams County:* Hamiltonban; *Berks County:* Boyertown, and Jones mine; *Chester County:* Wheatley mines (chalcotrichite); *Lancaster County:* Glenwood Station; *Lebanon County:* Cornwall (chalcotrichite); *Montgomery County:* Hendricks Station, and Perkiomen mine (chalcotrichite); *Northampton County:* Chestnut Hill; *Philadelphia:* Frankford, and O'Neill's quarry.

HYDROCUPRITE

Color: orange-yellow to orange-red. Amorphous, forming thin rag-like coatings on magnetite. The mineral is perhaps a hydrated cuprite with the composition Cu_2O, H_2O.

LOCALITY: *Lebanon County:* Cornwall.

MELACONITE

CuO AMORPHOUS?

Color: black. Luster: dull, earthy. Opaque. Form: massive, pulverulent. Sp. gr. 6.

Composition: CuO; Cu 79.8, O 20.2, = 100.

LOCALITIES: *Bradford County:* Carpenter mine (New Albany); *Berks County:* Jones mine, and Gickerville; *Chester County:* Wheatley mines; *Lancaster County:* Glenwood Station; *Montgomery County:* Perkiomen mine, and Sumneytown; *York County:* Franklintown.

[19] An old analysis of a mixture by Seybert (1821, 142) is omitted.

CORUNDUM

Al_2O_3 RHOMBOHEDRAL

Color: blue, red, yellow, brown, or gray. Transparent to translucent. Luster: adamantine to vitreous. Occasionally shows asterism. Form: barrel shaped crystals; massive. H = 9. Sp. gr. 3.95–4.10.

Crystallography: Rhombohedral; c = 1.3636; p_0 = 0.9091. Common forms: *c* (0001), *a* ($11\bar{2}0$), and *v* ($44\bar{8}1$). Crystals are usually rough and rounded. Prominent parting occurs parallel to *c* (0001) and *r* ($10\bar{1}1$).

Composition: Al_2O_3; Al 52.9, O 47.1, = 100.

Analysis: Shimersville, Lehigh County. E. F. Smith, Am. Chem. J., 5, 275, 1883.

Al_2O_3	85.75
Fe_2O_3	4.26
CaO	1.99
MgO	tr.
TiO_2	2.74
SiO_2	3.28
H_2O	1.37
	99.39
Sp. gr.	3.898

LOCALITIES: *Chester County:* Corundum Hill (Newlin; white or brownish-gray crystals in albite, tourmaline, and margarite); Fremont, Mt. Rocky Meeting House (East Nottingham); *Delaware County:* Black Horse (white to brown bipyramidal crystals in the soil); Elwyn, Mineral Hill, Morgan Station (large bronzy crystals sheathed with margarite), Smedley's iron mine, Sycamore Mills, and William's farm (Middletown); *Lehigh County:* Shimersville (rough crystals up to 8×15 cm. with feldspar and mica); *Montgomery County:* opposite Lafayette (small crystals in chlorite schist); *Philadelphia:* Chestnut Hill.

HEMATITE

Fe_2O_3 RHOMBOHEDRAL

Color: dark steel-gray to iron-black; when earthy, red. Streak: cherry-red to reddish-brown. Opaque. Luster: metallic, sometimes dull. Form: columnar, fibrous, lamellar, botryoidal, granular, or massive; crystals are tabular. H = 5.5–6.5. Sp. gr. 4.9–5.3.

Crystallography: Rhombohedral; c = 1.3623; p_0 = 0.9082. Common forms: *c* (0001), *r* ($10\bar{1}1$), and *m* ($10\bar{1}0$). Penetration twins occur, forming fine striae on *c*, which give rise to a distinct parting parallel to *r*.

Composition: Fe_2O_3; Fe 70, O 30, = 100.

LOCALITIES: *Adams County:* Franklin Valley, Gettysburg, and Hamiltonban; *Berks County:* Lobachsville, and Fritz Island; *Bucks County:* Durham, Finney's quarry, Janney, and Langhorne; *Chester County:* Chester Springs, Coatesville, Corundum Hill (Newlin), French Creek mines, Hopewell mines, Jug Hollow mines, London Grove, Pughtown, Springton, Warwick mines, Wheatley mines; *Dauphin County:* Hummelstown; *Delaware County:* Black Horse; *Huntingdon County:* Wray's Hill tunnel; *Lancaster County:* Wood's chrome mine; *Lebanon County*: Cornwall; *Lehigh County:* Hosensack Station, Shimersville; *Montgomery County:* Ecton mine, Edge Hill, Henderson, Huntingdon Valley Station, Jarrettown, Marble Hall, Perkiomen mine, Sumneytown, Willow Grove, Wyncote; *Northampton County:* Chestnut Hill; *Philadelphia:* Chestnut Hill, Germantown, Rittenhouse quarry, Wissahickon Valley; *York County:* Hellam, New Holland, Wrightsville, and York.

MARTITE

Martite is hematite pseudomorphous after magnetite or pyrite. Color: black. streak: reddish-brown; H = 6–7; Sp. gr. 4.809–4.832. Occurs in octahedral crystals, distin. guished from magnetite by the streak and lack of pronounced action on the magnetic needle.

LOCALITIES: *Bucks County:* Morrisville, in Chickies quartzite; *Montgomery County.* Edge Mill; *Northampton County:* Redington.

ILMENITE

$FeTiO_3$ RHOMBOHEDRAL (Trapezohedral)

Color: iron-black. Streak: black to brownish-red. Opaque. Luster: submetallic. Form: thick tabular crystals, sometimes curved. H = 5–6. Sp. gr. 4.5–5.

Crystallography: Rhombohedral, trapezohedral; c = 1.3846; p_0 = 0.9231. Common forms: *c* (0001), *a* ($11\bar{2}0$), *r* ($10\bar{1}1$), and *m* ($10\bar{1}0$). Habit: thick tabular, crystals often curved. Fracture: conchoidal.

Composition: $FeTiO_3$; Fe 36.8, Ti 31.6, O 31.6, = 100. The ratio of Fe:Ti varies widely.

Synonym: menaccanite.

Analyses: A. Girard Avenue Bridge, top of tunnel of Park Drive. Collected in 1904. The writer is indebted to Dr. Edgar T. Wherry for this unpublished analysis. B. Near Adamstown, Lancaster County. Large crystals in quartz. Smith, 1885, 413; analysis by Knerr and Brunner.

	A	B
Fe_2O_3	57.54	53.36
FeO	19.71	32.38
TiO_2	21.96	13.31
SiO_2	0.57	0.50
	99.78	99.55

LOCALITIES: *Bucks County:* Neshaminy Falls, Newportville; *Chester County:* Brinton's quarry (Westtown), Brinton's farm (Thornbury), Copesville, Corundum Hill (Newlin), Lewisville; *Delaware County:* Avondale, Chester, Custer's farm (Darby), Dickinson's Mill, Franklin Paper Mill, Leiperville, Marple, Morgan Station, Morton, Springfield quarry, Strath Haven Inn. Worrall's farm (Upper Providence); *Lancaster County:* Adamstown, Baumgardner, New Holland, Rock Springs Run, Texas, and Wood's chrome mine; *Montgomery County:* Conshohocken, opposite Lafayette, Flat Rock Tunnel, and Paper Mills Station; *Northampton County:* Chestnut Hill; *Philadelphia:* Bridesburg (in Delaware River sands), Fairmount Park (large tabular crystals, often curved), Logan, Prince's quarry, Schuylkill River sands and gravels, Tacony Creek, Wingohocking Creek Valley, and Wissahickon Valley.

SPINEL

$MgAl_2O_4$ ISOMETRIC

Color: black, brown, red, yellow, blue, green. Streak: white. Luster: vitreous, splendent to dull. Transparent to opaque. Form: octahedral cystals. Brittle. H = 8. Sp. gr. 3.5–4.1.

Composition: $MgAl_2O_4$; MgO 28.2, Al_2O_3 71.8, = 100. Mg is usually replaced by Fe^{II} or Mn, and Al by Fe^{III} or Cr.

Varieties: Ceylonite or pleonaste: $(Mg,Fe)Al_2O_4$. Dark green, brown to black; opaque. Sp. gr. 3.5–3.6. Picotite: $(Mg,Fe)(Al,Fe,Cr)_2O_4$. Yellowish- to greenish-brown, translucent to nearly opaque. Sp. gr. 4.08.

Analyses: A. One mile from Unionville, on the Kennett Square road, Chester County. Black, associated with talc, actinolite, chlorite and corundum. Genth, 1873, 370; analysis by Koenig. B. Shimersville, Lehigh County. Iron-black. Sp. gr. 4.056. Genth, 1882, 383; analysis by George M. Lawrence. 1.47 % SiO_2 has been deducted from the analysis. C. The same, recalculated.

	A	B		C
Al_2O_3	54.61	56.42		
Fe_2O_3	4.10	13.17	$MgAl_2O_4$	25.40
FeO	10.67	22.95	$FeAl_2O_4$	48.51
MgO	13.83	4.94	$FeFe_2O_4$	26.09
TiO_2	—	2.62		
SiO_2	1.26	—		
Corundum	16.24	—		
	100.71	100.10		100.00

LOCALITIES: *Chester County:* Corundum Hill (Newlin); *Lehigh County:* Shimersville; *Northampton County:* Redington.

GAHNITE

$ZnAl_2O_4$ ISOMETRIC

Color: dark green. Luster: vitreous, sometimes greasy. Subtransparent to nearly opaque. Form: octahedral crystals. H = 7.5–8. Sp. gr. 4.0–4.6.

Crystallography: Isometric; common forms: *o* (111), *a* (100), and *d* (110). Habit: octahedral. Cleavage: *o*, indistinct. Fracture: conchoidal, uneven.

Composition: $ZnAl_2O_4$; ZnO 44.3, Al_2O_3 55.7, = 100. Zn may be replaced by Mn or Fe^{II}, and Al by Fe^{III}.

Analysis: John Smedley's quarry, 1/2 mile northeast of Lima, P. O., Middletown township, Delaware County. Dark green crystals with muscovite and albite. Genth, 1889, 50.

Al_2O_3	57.22
ZnO	38.14
CuO	0.06
MnO	0.70
FeO	3.55
MgO	0.26
	99.93
Sp. Gr.	4.587

LOCALITIES: *Delaware County:* Chelsea; Smedley's quarry (dark green crystals measuring 15 mm. in muscovite), Sharpless' quarry near Glen Mills; *Chester County:* Swayne's farm (Pennsbury).

MAGNETITE

$FeFe_2O_4$ ISOMETRIC

Color: iron-black; in exceedingly thin plates dark brown, smoky-brown to almost colorless. Opaque; in very thin plates, translucent. Luster: metallic and splendent to submetallic and dull. Form: octahedral or dodecahedral crystals; massive, laminated, granular; in dendrites between plates of muscovite. Strongly magnetic, sometimes showing polarity. Brittle. H = 5.5–6.5. Sp. gr. 5.168–5.180.

Crystallography: Isometric; common forms: *a* (100), *d* (110), and *o* (111). Twins not uncommon; twin-plane *o*. Parting octahedral. Fracture: subconchoidal to uneven.

Composition: $FeFe_2O_4$; Fe_2O_3 69.0, FeO 31.0, = 100. Sometimes contains Ti.

LOCALITIES: *Adams County:* Cashtown, Gettysburg; *Berks County:* Blandon, Boyertown, Fritz Island, Huff Church, Jones mine (octahedral and dodecahedral crystals), Pricetown, Raudenbush mine, Ruth mine, Siessholtzville, Wheatfield mines; *Bucks County:* Flushing, Newportville, and Taylor's Woods; *Chester County:* Brinton's quarry, Corundum Hill (Newlin), Edward's quarry near Goshenville (lodestone), French Creek mines (brilliant octahedral crystals), Hopewell mines, Pughtown, Springton, Steele's mine, Swayne's farm (Pennsbury: reticulated, dendritic, in muscovite), Taylor's quarry, Warwick mines; *Columbia County:* Espy mine; *Dauphin County:* Hummelstown; *Delaware County:* Avondale, Castle Rock, The Hunt, Moro Phillip's chrome mine, Morton, Worrall, and Williamson School; *Lancaster County:* Carter's chrome mine, Marticsville, Rock Springs Run, and White Rock; *Lebanon County:* Cornwall (octahedral and dodecahedral crystals); *Montgomery County:* opposite Lafayette; *Northampton County:* Chestnut Hill, and Redington; *Philadelphia:* Bridesburg (in Delaware River sands), Frankford, Prince's quarry (octahedra in chlorite schists), Wissahickon Valley; *York County:* Dillsburg.

CHROMITE

$FeCr_2O_4$ ISOMETRIC

Color: iron-black. Opaque. Luster: submetallic to metallic. Form: massive, fine granular to compact; small octahedral crystals. Sometimes feebly magnetic. Brittle. H = 6.5. Sp. gr. 4.32–4.57.

Composition: $FeCr_2O_4$; Cr_2O_3 68.0, FeO 32.0, = 100.

Analyses: A. Hibbard's farm, Middletown, Delaware County. Crystals. Genth, 1875, 43. B. Wood's chrome mine, Lancaster County. Massive. Thomas Garrett, Am J. Sci. (2) 14, 45–48, 1852. The iron was determined as ferric iron, hence the high summation. C. Chester County. Crystals. Isaac Starr, Am. J. Sci., (2) 14, 45–48, 1852. D. Chester County. Massive. Seybert, Am. J. Sci., 4, 1822, 321.

	A	B	C	D
Cr_2O_3	53.36	63.38	60.84	51.56
Al_2O_3	5.98	——	0.93	9.72
Fe_2O_3	7.41	38.66	38.95	——
FeO	26.64	——	——	35.14
NiO	0.14	2.28	0.10	——
CoO	tr.	——	——	——
MnO	0.39	——	——	——
MgO	6.53	——	——	——
SiO_2	——	——	0.62	2.90
	100.45	104.32	101.44	99.32
Sp. gr.	4.780	4.568		

LOCALITIES: *Chester County:* Brinton's quarry, Corrine, Corundum Hill (Newlin), Edward's quarry, Elk township, Moro Phillip's chrome mine (West Nottingham), Northbrook, Octoraro Creek, Oxford, Scott's chrome mine, Taylor's quarry, Webb's quarry, Willistown; *Delaware County:* Black Horse (large brilliant octahedra in the sands of Chrome Run on Hibbard's farm), Blue Hill, Elwyn, The Hunt, Mineral Hill, Moro Phillip's chrome mine (Marple), Radnor, Williamson School, Worrall; *Lancaster County:* Wood's chrome mine, and Low's mine; *Philadelphia:* Wissahickon Valley.

HAUSMANNITE

$MnMn_2O_4$ TETRAGONAL

Color: brownish-black. Streak brown. Luster: submetallic. Opaque. Form: pyramidal crystals, granular masses. H = 5–5.5. Sp. gr. 4.8.

Composition: MnO 31.0, Mn_2O_3 69.0, = 100.

LOCALITY: *Lebanon County:* Cornwall?

CREDNERITE

$Cu_2Mn_4O_9$ MONOCLINIC

Color: iron-black to steel-gray. Streak black, brownish. Luster: metallic. Opaque. Form: foliated masses. H = 4.5. Sp. gr. 5.

Composition: CuO 43.0, Mn_2O_3 57.0, = 100.

LOCALITY: *Lebanon County:* Cornwall? (Cobaltiferous.)

BRAUNITE

$3Mn_2O_3.MnSiO_3$ TETRAGONAL

Color: brownish-black to steel-gray. Luster: submetallic. Opaque. Form: pyramidal crystals; massive. H = 6–6.5. Sp. gr. 4.75–4.82.

Composition: MnO 11.7, Mn_2O_3 78.3, SiO_2 10.0, = 100.

LOCALITY: braunite has been reported from Oreland, Montgomery County, but its occurrence there is extremely doubtful.

RUTILE

TiO_2 TETRAGONAL

Color: red to reddish-brown. Streak: pale brown. Transparent to opaque. Luster: metallic adamantine. Form: acicular or prismatic crystals, often twinned; in reticulating needles. H = 6–6.5. Sp. gr. 4.18–4.25.

Crystallography: Tetragonal; c, p_0 = 0.6442. Common forms: *c* (001), *a* (100), *m* (110), *e* (101), *s* (111). Habit: prismatic, vertically striated and furrowed; and slender acicular. Geniculated twins, twin-plane *e*, are common. Cleavage: *a* and *m* distinct.

Composition: TiO_2; Ti 60.0, O 40.0, = 100. Fe may replace Ti up to 10 %.

LOCALITIES: *Berks County:* Antietam Reservoir; *Bucks County:* Knight's quarry, Vanartsdalen's quarry; *Chester County:* Avondale, Bailey's quarry (West Marlboro), Black Horse Inn, Brinton's farm (Thornbury), Coatesville, Cope's quarry, Corundum Hill (Newlin), Doe Run quarries, Edward's quarry (Newlin), Logan's quarry (acicular crystals up to 10 cm. long), Nevin's quarry, Octoraro Creek, Pomeroy, Poorhouse quarry (brilliant acicular and prismatic crystals on quartz), Pusey's quarries, Sadsbury township between Parkesburg and Christiana (large twinned crystals found in the soil), West Sadsbury; *Delaware County:* Birmingham township Concord township, Darby, Edgemont, Morgan Station (small ruby-red crystals on quartz), Marshall's and Tyler's farm on Dismal Run (in amethyst), near Peter's mill dam (Aston), Worrall's farm (Upper Providence); *Lancaster County:* Kinzer (acicular crystals in quartz), Pequa mines; *Montgomery County:* Edge Hill (on hematite), Flourtown; *Philadelphia:* Overbrook (minute brilliant ruby-red crystals on quartz), Prince's quarry, Tacony Creek (in amethyst), Wingohocking Creek Valley (veins of brilliant red, reddish-brown or black reticulated acicular crystals in quartz), Wissahickon Valley.

OCTAHEDRITE

TiO_2 TETRAGONAL

Color: brown. Streak uncolored. Luster: adamantine. Transparent to nearly opaque Form: pyramidal crystals. Brittle. H = 5.5–6. Sp. gr. 3.82–3.95.

Crystallography: Tetragonal; c, p_0 = 1.7771. Common forms: *c* (001), *m* (110), and *p* (111). Cleavage: *c* and *p*, perfect. Habit: octahedral, sometimes tabular.

Composition: TiO_2, Ti 60.0, O 40.0, = 100.

LOCALITY: *Chester County:* Phoenixville tunnel?

BROOKITE

TiO_2 ORTHORHOMBIC

Color: brown, black, reddish and yellowish. Streak: uncolored to gray or yellowish. Luster: metallic adamantine to submetallic. Translucent to opaque. Form: prismatic crystals. H = 5.5–6. Sp. gr. 3.87–4.01.

Crystallography: Orthorhombic; a : b : c = 0.8416 : 1 : 0.9444;
$p_0:q_0: r_0$ = 1.1222: 0.9444 : 1.

Common forms: *m* (100), *a* (100), *b* (010), *s* (112), *e* (122), *c* (001). Habit: prismatic. Cleavage: *m* and *c*, indistinct.

Composition: TiO_2, Ti 60.0, O 40.0, = 100.

LOCALITIES: *Chester County:* Octoraro Creek placers; Phoenixville Tunnel (crystals on quartz); *Delaware County:* Black Horse; *Lancaster County:* Carter's chrome mine (iron-black prismatic crystals 2 cm. in length).

PYROLUSITE

MnO_2 ORTHORHOMBIC?

Color: iron-black, dark steel-gray to bluish. Streak: black or bluish-black. Luster: metallic. Opaque. Form: columnar, often divergent; granular, massive; reniform coatings or druses. H = 2–2.5; soft, often soiling the fingers. Sp. gr. 4.73–4.86.

Composition: MnO_2; usually contains some water.

Analysis: Near Mountainville, Lehigh County. Coating the interior of limonite geodes E. F. Smith, Am. Chem. J., 5, 277, 1883.

MnO_2	82.66
Mn_3O_4	3.13
Fe_2O_3	4.21
Al_2O_3	tr.
SiO_2	9.93
	99.93

LOCALITIES: *Bedford County:* Robinsonville (Wray's Hill); *Bradford County:* Barclay; *Berks County:* Great Valley iron mines; *Chester County:* Osborn Hill; *Lancaster County:* Glenwood Station; *Lehigh County:* Friedensville, Ironton, Macungie, Mountainville; *Luzerne County:* Bear Creek; *Monroe County:* Broad Mountain; *Montgomery County:* Marble Hall, Oreland, Spring Mill; *Northampton County:* Bingen.

DIASPORE

$H_2Al_2O_4$ ORTHORHOMBIC

Color: white, grayish-white, greenish-gray, hair-brown, yellowish, or colorless. Transparent to translucent. Luster: brilliant; pearly on cleavage faces, elsewhere vitreous. Form: prismatic crystals, sometimes acicular; thin scales and foliated masses. Brittle. H = 6.5–7. Sp. gr. 3.3–3.5.

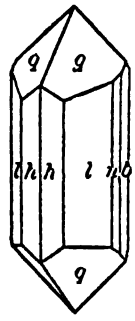
Crystallography: Orthorhombic; a : b : c = 0.9372 : 1 : 0.6039;

$p_0 : q_0 : r_0 = 0.6444 : 0.6039 : 1.$

Forms: *h* (210), *l* (120), *n* (150), *b* (010), *q* (232). Habit: prismatic, usually thin parallel to *b;* sometime acicular; faces often rounded, and vertically striated in the prism zone. Cleavage: *b* eminent, *h* less perfect. Fracture: conchoidal.

Composition: $H_2Al_2O_4$; Al_2O_3 85.0, H_2O 15.0, = 100.

Analysis: Corundum Hill, Chester County. Dana, 1868, 169; analysis by Sharples.



29

Fig. 29. Diaspore, Newlin, Chester County (*Dana*).

Al_2O_3	80.95
Fe_2O_3	3.12
SiO_2	1.53
H_2O	14.84
	100.44

LOCALITY: *Chester County:* Corundum Hill (Newlin), white, honey-yellow or greenish-yellow laminated masses; brilliant crystals, doubly terminated, up to 5 cm. in length.

GOETHITE

$H_2Fe_2O_4$ ORTHORHOMBIC

Color: blackish-brown, reddish, yellowish. Streak: dull orange-yellow. Opaque. Luster: subadamantine, submetallic, silky, or dull. Form: prismatic crystals; bladed and fibrous masses often forming geodes. H = 5–5.5. Sp. gr. 4.28±. When crystallized in aggregates of thin blades and fibres with much adsorbed and capillary H_2O it has been called limonite; but all such crystallized material is goethite.

Crystallography:[80] Orthorhombic; a : b : c = 0.91 : 1 : 0.602;

$p_0 : q_0 : r_0 = 0.660 : 0.602 : 1.$

Common: forms: *m* (110), *d* (210), *b* (010), *p* (111) and *e* (011). Habit: prismatic, vertically striated, often flattened into scales or tables. Cleavage: *b* very perfect. Fracture uneven. Pleochroism faint; $\alpha = 2.26$, $\beta = 2.394$, $\gamma = 2.400$.

Composition: $H_2Fe_2O_4$; Fe_2O_3 89.9, H_2O 10.1, = 100; Fe 62.9.

Analyses: A. Easton, Pa. Posnjak and Merwin, 1919, 316. B. Moselem, Berks County. Posnjak and Merwin, 1919, 316. $\alpha = 2.14$, $\gamma = 2.22$. "Limonite." C. Bull Bank, Center County. "Limonite." Fibrous, pale brown. Genth, 1875, 51. D. Dry Hollow Mine, Huntingdon County. "Limonite." Fibrous, dark brown. Genth, 1875, 51. E. Pennsylvania bank, Huntingdon County. "Limonite pipe." Genth, 1875, 51.

[80] E. Posnjak and H. E. Merwin, The hydrated ferric oxides; Am. J. Sci., (4) 47, 311–348, 1919; see also Spencer, Mineralog. Mag., 18 (86), 339, 1919, on turite.

	A	B	C	D	E
Fe_2O_3	82.67	81.15	81.48	83.13	83.74
FeO	1.82	1.50	——	——	——
CoO	——	——	——	——	tr.
Al_2O_3	0.24	0.10	0.49	0.74	0.33
Mn_2O_3	1.24	0.55	0.07	0.15	0.31
CaO	none	0.06	tr.	tr.	tr.
MgO	0.12	0.40		0.09	0.34
SiO_2	0.92	2.26	3.98	2.47	2.57
P_2O_5	——	——	0.08	0.50	0.14
CO_2	1.09	0.92	——	——	——
H_2O	11.68	12.80	13.90	12.92	12.13
Quartz	——	——	——	——	0.44
	99.78	99.74	100.00	100.00	100.00
$\frac{H_2O}{Fe_2O_3}$	1.25	1.40	1.52	1.38	1.29

LOCALITIES: Goethite ("limonite") occurs as residual weathering deposits of the Cambro-ordovician limestones and shales in the Chester, Great, Kishacoquillas, and Nittany Valleys.[81] Only localities that have been noted in mineralogical literature are listed here. *Berks County:* southwest of Reading, Salem Church (Alsace, geodes up to 60 dcm.), Moselem mines, Sinking Spring, and Udreé mine; *Center County:* Nittany Valley; *Chester County:* Chester Springs, Fremont (geodes), Oakland, Oxford, Trimble's mine, and Wheatley mines; *Delaware County:* Castle Rock, Smedley's mine, and Newtown Square; *Huntingdon County:* near Chester Furnace (containing Co); *Lancaster County:* Chestnut Hill, Marietta, and Safe Harbor; *Montgomery County:* Bridgeport, Henderson, Marble Hall, Oreland, Spring Mill; *Northampton County:* Bingen, South Easton; *York County:* Ore Valley, Margaretta Furnace.

TURGITE.[82] Color: black with a reddish tinge. Streak: red. Luster: submetallic, or silky. Opaque. Form: mammillary or botryoidal masses, with a fibrous structure, frequently forming a layer on goethite ("limonite"). Sp. gr. ±4.35.

Composition: variable; turgite is probably a solid solution of goethite and hematite with enclosed and adsorbed water.

Analyses:[83] A. Red incrustation on interior of "limonite" geode, Glendon, Easton, Northampton County; Eyerman, 1911, 22. B. Hitner's pit, Montgomery County; Eyerman, 1911, 22.

	A	B
Fe_2O_3	86.41	78.01
MnO	8.60	3.61
SiO_2	——	1.21
H_2O	5.06	17.64
	100.07	100.47
$\frac{H_2O}{Fe_2O_3}$	1.92	2.00

LOCALITIES: *Berks County:* Great Valley iron mines, Moselem mines, Mt. Penn, and Udreé mine; *Chester County:* Chester Springs; *Lancaster County:* Providence township; *Montgomery County:* Henderson, Oreland, Marble Hall, and Spring Mill; *Northampton County:* Bingen, South Easton; *York County:* Margaretta Furnace, Ore Valley.

[81] Thomas C. Hopkins, Cambro-silurian limonite ores in Pennsylvania; Bull. Geol. Soc. Am., XI, 475–502, 1900. Descriptions of individual pits are given in the reports of the First and Second Geological Surveys of Pennsylvania.

[82] E. Posnjak and H. E. Merwin, The hydrated ferric oxides, Am. J. Sci., (4). 47, 311–348, 1919, also Spencer, The mineralogical characters of turite, Mineralogical Magazine, 18 (86), 339, 1919

[83] An analysis of a mixture by Beck (1912, 5) is omitted.

LEPIDOCROCITE[34]

$H_2Fe_2O_4$ ORTHORHOMBIC

Color: reddish, often blood-red by transmitted light. Streak: dull orange. Luster: imperfect adamantine. Form: thin scales, or scaly to compact bladed aggregates. Sp. gr. 4.09 ±0.04.

Crystallography: Orthorhombic: a : b : c = 0.43 : 1 : 0.64;

$$p_0 : q_0 : r_0 = 1.500 : 0.640 : 1.$$

Habit: scales slightly elongated parallel to *c*. Cleavage (010) perfect; (001) less perfect; (100) good. Optical orientation: $\alpha = b$, $\beta = a$, $\gamma = c$; 2V = 83°. $\alpha = 1.94$, $\beta = 2.20$, $\gamma = 2.51$. Pleochroism strong; α clear yellow, β dark orange-red, γ darker orange-red.

Composition: $H_2Fe_2O_4$; Fe_2O_3 89.9, H_2O 10.1, = 100; Fe = 62.9.

Analysis: Easton, Northampton County. Micaceous, orange-red, on fibrous goethite. $\alpha_{Na} = 1.935$, $\beta_{Na} = 2.20$, $\gamma_{Na} = 2.515$, $\gamma_{Li} = 2.425$. Posnjak and Merwin, 1919, 316.

Fe_2O_3	85.80
FeO	1.47
Al_2O_3	——
Mn_2O_3	tr.
SiO_2	0.91
CO_2	0.90
H_2O	11.02
	100.10
$\frac{H_2O}{Fe_2O_3}$	1.14

LOCALITIES: *Berks County:* Mt. Penn, Reading, Udreé mine; *Chester County:* Chester Springs; *Lancaster County:* Chestnut Hill; *Montgomery County:* Marble Hall, Oreland, Spring Mill; *Northampton County:* South Easton; *York County:* Ore Valley.

GIBBSITE

$Al(OH)_3$ MONOCLINIC

Color: white, grayish or greenish. Translucent. Luster: *c* pearly, elsewhere vitreous. Form: small tabular crystals; mammillary, stalactitic, incrusting, with usually a fibrous structure. H = 2.5–3.5. Sp. gr. 2.3–2.4.

Composition: $Al(OH)_3$. Al_2O_3 65.4, H_2O 34.6, = 100.

Analysis:[35] General Trimble's mine, East Whiteland township, Chester County. Grayish, pearly, subtranslucent coating on limonite. Hermann, 1869, 496.

Al_2O_3	63.84
Fe_2O_3, MgO	tr.
SiO_2	1.50
P_2O_5	0.91
H_2O	33.45
	99.70

LOCALITIES: *Chester County:* Corundum Hill (Newlin, on corundum); Chester Springs; General Trimble's mine (East Whiteland), on wavellite.

BRUCITE

$Mg(OH)_2$ RHOMBOHEDRAL

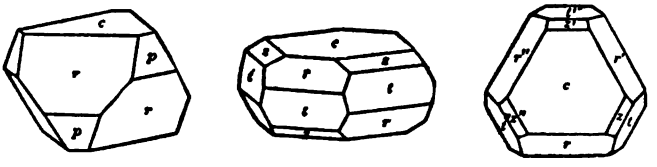
Color: white, grayish, blue, or green. Transparent to translucent. Luster: *c* pearly,

[34] E. Posnjak and H. E. Merwin, The hydrated ferric oxides, Am. J. Sci., (4) 47, 311–348, 1919.

[35] From preliminary tests Genth (1890, 206) concluded that the mineral from Trimble's mine was a hydrous aluminum phosphate. Genth's material was probably a mixture of wavellite and gibbsite.

elsewhere waxy to vitreous. Form: broad tabular crystals; foliated or fibrous masses. H = 2.5. Sp. gr. 2.38–2.4.

Crystallography: Rhombohedral; c = 1.5208; p_0 = 1.0139. Forms: *c* (0001), *a* ($11\bar{2}0$), r_{Δ}^{-}($10\bar{1}1$), *p* ($20\bar{2}1$), *s* ($01\bar{1}3$), *e* ($01\bar{1}2$), *h* ($07\bar{7}5$), *t* ($04\bar{4}1$). Cleavage: *c* eminent, folia separable and flexible.



30 31 32

Figs. 30–32. Brucite, Texas, Lancaster County (30, *Hessenberg;* 31–32, *Dana*). 30, Low's mine; 31 and 32, Wood's mine.

Composition: $Mg(OH)_2$; MgO 69.0, H_2O 31.0, = 100. Synonym: texalith.

Analyses: Wood's Chrome Mine, Lancaster County. A. Clarke and Schneider, 1890, 456. B. Smith and Brush, 1853, 214. Foliated. C. Smith and Brush, 1853, 214. D. Hermann, 1861, 368; Low's mine, Lancaster County.

	A	B	C	D
MgO	67.97	66.30	66.25	68.87
FeO	n. det.	0.50	1.00	——
MnO	.97	tr.		0.80
Fe_2O_3	.39	——	——	——
CO_2	——	1.27	tr.	——
H_2O	30.81	31.93	32.75	30.33
	100.14	100.00	100.00	100.00

E. Fritz Island, Berks County. Colorless crystals, Genth, 1885, 41. F–G. Fritz Island. Brownish-yellow; Genth, l. c. H. Fritz Island. Crystalline masses. Schoenfeld and Smith, 1883, 281. I. Two miles south of Sinking Spring, Berks County. Silky fibrous masses. Genth, l. c. J. Two miles south of Sinking Spring. Thin colorless laminae. Schoenfeld and Smith, 1883, 281.

	E	F	G	H	I	J
MgO	67.64	65.38	64.30	66.78	66.62	66.19
CaO	——	——	——	——	0.11	1.68
MnO	0.63	4.04	4.66	——	——	——
Fe_2O_3	0.82	0.30	0.04	0.44	0.75	1.24
Al_2O_3, SiO_2	——	——	0.46	——	——	——
CO_2	——	——	——	——	2.42	——
H_2O	30.92	29.70	29.47	32.52	29.91	31.05
	100.01	29.42	98.93	99.74	99.81	100.16

K. Dehydration tests. Brucite, Wood's mine, Lancaster Co. Clarke and Schneider, 1890, 456.

H_2O lost at 105°	0.18
H_2O lost at 250°	0.46
H_2O lost at 383°–412°, 2 hours	7.57
H_2O lost at 383°–412°, 3 hours more	19.37
H_2O lost at 383°–412°, 2 hours more	0.06
H_2O lost at 498°–527°, 1 hour	0.23
H_2O lost at 498°–527°, 1 hour more	none
H_2O lost at full ignition	2.94

LOCALITIES: *Berks County:* Fritz Island, Ruth mine; *Chester County:* Corundum Hill (Newlin)? *Lancaster County:* Low's mine, Wood's mine, (large tabular crystals often in rosettes, and broad foliated masses).

LIMONITE

$Fe_2O_3.H_2O.aq.$ AMORPHOUS

Color: dark brown, black, brownish-yellow to ochre-yellow. Streak: yellowish-brown. Luster: dull, earthy, or submetallic. Opaque. Form: massive, earthy. H = 5–5.5. Sp. gr. 3.6–4.0.

Much fibrous material has been called limonite, but all such crystallized material is goethite, limonite including only the amorphous ferric hydrate with adsorbed water.

Composition: $Fe_2O_3.H_2O$ with more or less adsorbed water. Fe =59.8. Xanthosiderite contains much adsorbed water; color: yellow to brownish; form: massive (ochre). Melanosiderite:[36] is a black, vitreous to resinous, compact, amorphous mixture of limonite and silica; sp. gr. 3.390–3.392.

Analyses: A. Middletown, Delaware County. Pitch-black. Genth, 1875, 51; 1876, 215. Sydney Castle, analyst. B. Wheatley mine, Chester County. Liver-brown, compact. J. L. Smith, 1855, 251.

	A	B
Fe_2O_3	74.57	80.32
Mn_2O_3	2.58	——
Al_2O_3	1.54	——
CoO	0.60	——
CuO	——	0.94
PbO	——	1.51
P_2O_5	0.13	——
SiO_2	6.90	3.42
H_2O	13.10	14.02
	99.42	100.21

Melanosiderite: impure limonite, Middletown, Delaware County. C. Average of 3 analyses by W. H. Melville; Cooke, 1875, 451. D. Dried over H_2SO_4 for 24 hours (air-dry, H_2O = 15.95). Genth, 1876, 216. E. Calculated for mineral dried 2 months, Genth, l. c. F. Air dry, Genth, l. c. G. Calculated for mineral dried 1 month, Genth, l. c.

	C	D	E	F	G
Fe_2O_3	75.13	79.53	80.37	73.00	78.25
Al_2O_3	4.34	——	——	2.71	2.91
Mn_2O_3	——	1.08	1.08	0.40	0.43
CoO	——	0.39	0.39	0.16	0.17
SiO_2	7.42	7.38	7.47	7.27	7.79
P_2O_5	——	0.26	0.26	tr.	tr.
H_2O at 100°	13.83	——	——	——	——
H_2O above 100°					
Ignition	——	11.48	10.43	17.19	10.45
	100.72	100.12	100.00	100.73	100.00
Sp. gr	3.140	3.165	3.186	3.203	3.326

LOCALITIES: *Bedford County:* Robinsonville (Wray's Hill); *Berks County:* Blandon, Fleetwood, Flint Hill, Fritz Island, Lyons (xanthosiderite), Pricetown (xanthosiderite), Reading, Salem Church (ochre in goethite geodes), Siessholtzville, Udreé mine, Wheatfield mines; *Bucks County:* Hilcroft, Newportville, Vanartsdalen's quarry; *Chester County:* Brinton's quarry, Charlestown township, Chester Springs, Hallman, General Trimble's mine. Wheatley mines; *Delaware County:* Castle Rock, Adele, The Hunt, Moro Phillip's chrome mine, Smedley's iron mine (melanosiderite); *Franklin County:* Mercersburg; *Lancaster County:* Beartown, Chestnut Hill, Quarry-

[36] Cooke, 1875, 451; Genth, 1876, 216.

ville; *Montgomery County:* Ecton mine, Marble Hall, Oreland, Perkiomen mine, Spring Mill; *Northampton County:* South Easton; *York County*: Margaretta Furnace, Ore Valley.

Limonite pseudomorphous after pyrite. *Berks County:* southwest of Reading; *Chester County:* Cedar Hollow, Coatesville, Goshenville, Mill Lane, Pomeroy, Springton, West Sadsbury township; *Delaware County:* Boothwyn, near Franklin Paper Mill, Upper Darby; *Lancaster County:* south of Neffsville Ridge near Fruitville, perfect pyritohedra and combinations of cube, octahedron and pyritohedron, up to 5 cm. *Montgomery County:* Flourtown, Henderson, Roslyn Heights, Shainline; *Northampton County:* Chestnut Hill; *Philadelphia:* Cobb's Creek, Falls of Schuylkill, Overbrook, and Rittenhouse quarry; *York County:* Schump's Hill south of York (cubes up to 15 cm.), Wrightsville, and York.

PSILOMELANE

$xMnO_2.yMnO.z(BaO,K_2O).H_2O$ AMORPHOUS

Color: iron-black to steel-gray. Streak: shining brownish-black. Luster: submetallic, dull. Opaque. Form: massive, reniform, botryoidal, stalactitic. H = 5–6. Sp. gr. 3.7–4.7.

LITHIOPHORITE. Bluish-black, streak blackish-gray. Luster dull to metallic. Form: fine scales, compact, botryoidal. Contains 10–15% Al_2O_3, 1.2–1.4% Li_2O, and 12.6–15. % H_2O.

WAD. Dull black, bluish or brownish-black. Form: amorphous and reniform masses, earthy, compact, or incrusting. H = 1–3, often soiling the fingers. Sp. gr. 3.0–4.26. Composition: hydrated oxides of Mn, with Co, Cu, Fe, and 10 to 20% H_2O. Asbolite contains Co; lampadite contains Cu.

Analyses: A. "Psilomelane," Ironton, Lehigh County. Analysis of a mixture of psilomelane and pyrolusite by Henry Pemberton, Jr., Genth, 1876, 217. B. Psilomelane, 1 mile south of Hellertown, Northampton County; Wherry, 1915, 508; J. S. Long, analyst. C. Psilomelane, Beartown, Lancaster County. Beck, 1912, 5. D. Wad, P. & R. Coal & Iron Co. mine, near Alburtis, Lehigh County; Genth, 1875, 54, W. T. Roepper, analyst.

	A	B	C	D
MnO_2	84.88	——	56.75	——
MnO	3.77	——	31.30	——
Mn_2O_3	——	50.5	——	23.64
Fe_2O_3	——	4.5	6.44	19.29
CoO	1.68	——	1.27	——
NiO	tr.	——		——
MgO	0.79	——	——	0.34
CaO	1.90	——	——	——
BaO	tr.	——	——	——
Na_2O	0.19	——	——	——
K_2O	3.50	——	——	——
SiO_2	——	12.0	1.80	——
P_2O_5	tr.	3.2	——	0.29
H_2O	4.38	22.1	2.44	11.04
Clay	——	——	——	45.66
	101.09	(92.3)	100.00	100.26

LOCALITIES: Psilomelane: *Berks County:* Great Valley iron mines, Green Hill; *Center County:* Nittany Valley; *Cumberland County:* Mt. Holly Springs; *Huntingdon County:* Chester Furnace; *Lancaster County:* Beartown; *Lehigh County:* Ironton; *Luzerne County:* Bear Creek; *Monroe County:* Broad Mountain; *Montgomery County:* Marble Hall, Oreland; *Northampton County:* Hellertown, South Easton; *Philadelphia:* Holmesburg.

Wad. *Berks County:* Clymer mines, Great Valley iron mines, Birdsboro, Lyons, Maiden Creek, Oakland; *Bucks County:* Buckingham Mountain; *Chester County:* Chester Springs, Osborn Hill, Pughtown; *Delaware County:* Chelsea, and Edgemont; *Huntingdon County:* Robinsonville (Wray's Hill); *Lancaster County:* Lancaster; *Lebanon County:* Cornwall; *Lehigh County:* Alburtis, Friedensville; *Monroe County:* Broad Mountain; *Montgomery County:* Marble Hall, Oreland (asbolite); *Philadelphia:* Fairmount Park, Frankford, West Philadelphia; *Susquehanna County:* Great Bend.

CARBONATES

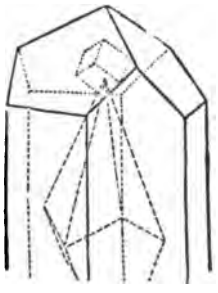
CALCITE	$CaCO_3$	Rhombohedral
DOLOMITE	$CaMg(CO_3)_2$	Rhombohedral
ANKERITE	$Ca(Mg,Fe)(CO_3)_2$	Rhombohedral
MAGNESITE	$MgCO_3$	Rhombohedral
BREUNNERITE	$(Mg,Fe)CO_3$	Rhombohedral
SIDERITE	$FeCO_3$	Rhombohedral
RHODOCHROSITE	$MnCO_3$	Rhombohedral
SMITHSONITE	$ZnCO_3$	Rhombohedral
ARAGONITE	$CaCO_3$	Orthorhombic
STRONTIANITE	$SrCO_3$	Orthorhombic
CERUSSITE	$PbCO_3$	Orthorhombic
MALACHITE	$Cu_2(OH)_2CO_3$	Monoclinic
AZURITE	$Cu_3(OH)_2(CO_3)_2$	Monoclinic
HYDROZINCITE	$Zn_5(OH)_6(CO_3)_2$	Monoclinic
AURICHALCITE	$(Zn,Cu)_5(OH)_6(CO_3)_2$	Monoclinic
NESQUEHONITE	$MgCO_3.3H_2O$	Orthorhombic
LANTHANITE	$La_2(CO_3)_3.9H_2O$	Orthorhombic
HYDROMAGNESITE	$Mg_4(OH)_2(CO_3)_3.3H_2O$	Monoclinic?
LANSFORDITE	$Mg_4(OH)_2(CO_3)_3.21H_2O$	Triclinic
ZARATITE	$Ni_3(OH)_4CO_3.4H_2O$	Amorphous
BISMUTITE	$Bi_2CO_5.H_2O$?	Amorphous?
RANDITE	$Ca_2U_2(CO_3)_5.6H_2O$?	

CALCITE

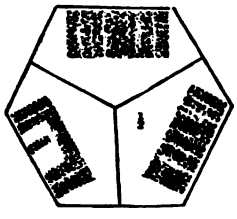
$CaCO_3$ RHOMBOHEDRAL

Colorless, white, gray, yellow, green, blue, black. Transparent to opaque. Luster: vitreous to subvitreous. Form: rhombohedral, scalenohedral, or hexagonal crystals; lamellar (argentine), granular, compact, or stalactitic masses. H = 3. Sp. gr. 2.713–2.723.

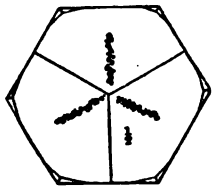
Crystallography: Rhombohedral; c = 0.8543; p_0 = 0.5695. Common forms: *m* (1010), *c* (0001), *e* (01$\bar{1}$2), *f* (02$\bar{2}$1), *r* (10$\bar{1}$1), M (40$\bar{4}$1), *v* (21$\bar{3}$1), *a* (11$\bar{2}$0), *y* (32$\bar{5}$1), *t* (21$\bar{3}$4). Twins: common, twin plane (0001), (01$\bar{1}$2), (10$\bar{1}$1), or (02$\bar{2}$1). Habit: rhombohedral, scalenohedral, or prismatic. Cleavage: *r* highly perfect. Parting parallel to *e* (01$\bar{1}$2) due to twinning.



33



34



35

Figs. 33–35. Calcite, Wheatley mines (*Smith*). 33, Enclosing fluorite; 34 and 35, with symmetrical enclosures of pyrite.

Composition: $CaCO_3$; CaO 56.0, CO_2 44.0, = 100. Ca may be replaced by small quantities of Mg, Fe, or Mn.

Analyses: A. De Turk's quarry, Alsace, Berks County. Small pale pink to rose-colored rhombohedra. Sp. gr. 2.79. Genth, 1876, 228; Dr. Hoffmann, analyst. B. "Manganocalcite." West Earl township, near Cocalico Creek, Lancaster County. Black, crystalline. Beck, 1912, 6.

	A	B
CaO	44.36	52.89
MgO	——	1.51
MnO	8.20	0.41
FeO	tr.	2.04
ZnO	——	0.19
Fe_2O_3	——	0.57
Al_2O_3	——	0.44
CO_2	41.65	41.23
SiO_2	——	0.82
Loss and H_2O	5.79	——
	100.00	100.10

LOCALITIES: *Allegheny County:* Pittsburgh; *Bedford County:* Cumberland Valley; *Berks County:* Crystal Cave, De Turk's quarries, Fritz Island, Fritztown, Great Valley, Greenwich township, Jacksonwald, Jones mine, Leinbach's Hill, Luckenbill's Cave, east of Poplar Neck, Gickerville, Reading, Ruth mine, Shillington, Birdsboro, Wernersville, Wheatfield mines; *Bucks County:* Edison, Finney's quarry, Grenoble, New Galena, Reeder, Rock Hill, and Vanartsdalen's quarry; *Chester County:* Avondale, Bailey's farm (East Marlboro), Charlestown mine, Dilworthtown, Doe Run quarries, Dowingtown, Edwards' quarry, French Creek mines (colorless, white, and green, rhombohedra and scalenohedra, enclosing byssolite), Howellville, Kimberton, Mendenhall's quarry, Oakland, Osborn Hill (fetid), Poorhouse quarry, Phillips' quarry, Phoenixville tunnel, Taylor's quarry, Warwick mines, Wheatley mines (large prismatic crystals, combinations of prism, scalenohedron, and rhombohedron; sometimes in spirally arranged groups; individuals occur with a cube of fluorite on the apex, or enclosed within the termination, or with pyrite symmetrically arranged on the rhombohedron); *Clarion County:* Mechanicsville; *Columbia County:* Espy mine; *Delaware County:* Avondale, Lenni, Ward's quarry (argentine); *Franklin County:* Chambersburg (travertine); *Huntingdon County:* Wray's Hill tunnel; *Lancaster County:* Adamstown, Lancaster, West Earl (manganocalcite), and Wood's chrome mine; *Lebanon County:* Cornwall; *Lehigh County:* Catasauqua; *Lycoming County:* Roaring Branch of Lycoming Creek; *Mifflin County:* opposite Mt. Union (ferrocalcite); *Montgomery County:* Camp Hill, Collegeville, Conshohocken, Flat Rock tunnel, Flourtown, Henderson, Hendricks Station, King of Prussia, Marble Hall, Mogeetown, Paper Mills Station, Perkiomen mine, Schwenksville, Spring Mill, Sumneytown, Swedeland, West Conshohocken; *Northampton County:* Chestnut Hill; *Philadelphia:* Germantown, Frankford, Fairmount Park, O'Neill's quarry, and Rittenhouse quarry; *York County:* Emigsville, Hanover, Hellam, New Holland, Spring Grove, Thomasville, Wrightsville, York, York Valley.

DOLOMITE

$CaMg(CO_3)_2$ RHOMBOHEDRAL (Tetartohedral)

Color: white, greenish-white, gray, reddish. Transparent to translucent. Luster: vitreous inclining to pearly. Form: curved rhombohedra or rhombohedral aggregates; granular masses. H = 3.5–4. Brittle. Sp. gr. 2.8–2.9.

Crystallography: Rhombohedral, tetartohedral; c = 0.8322; p_0 = 0.5548. Common forms: *r* $(10\bar{1}1)$, *c* (0001), and *M* $(40\bar{4}1)$. Polysynthetic twinning with the twin plane $(02\bar{2}1)$ gives rise to twin striations parallel to both the long and short diagonals of the rhombs. Cleavage: *r* perfect.

Composition: $CaMg(CO_3)_2$; CaO 30.4, MgO 21.7, CO_2 47.8, = 100. Fe and Mn may replace Ca and Mg.

PENNITE. A mixture of dolomite and zaratite has received the name pennite. The mineral occurs as apple-green to whitish crusts of minute hexagonal prisms of dolomite with an admixture of zaratite.

Analyses: A. Texas, Lancaster County. Crystalline masses with mammillary surfaces lining cavities and fissures in serpentine. Garrett, 1853, 334. B. "Pennite." Grayish-white, frequently colored green by a small admixture of zaratite, in incrustations of microscopic crystals. Genth, 1875, 156. C. "Pennite," Hermann, 1849, 13.

	A	B		C
$CaCO_3$	51.90	52.64	CaO	20.10
$MgCO_3$	46.86	46.83	MgO	27.02
$FeCO_3$	1.24	——	FeO	0.70
			NiO	1.25
			MnO	0.40
			Al_2O_3	0.15
			CO_2	44.54
			H_2O	5.84
	100.00	99.47		100.00

LOCALITIES: *Blair County:* Bellwood; *Berks County:* New Galena; *Chester County:* Avondale, Cope's quarry, Devault, Downingtown, Marshall's quarry, Nevin's quarry, Poorhouse quarry, Pusey's quarries, Wheatley mines; *Lancaster County:* Bamford, Carter's chrome mine, Texas, Wood's mine ("pennite"); *Lehigh County:* Friedensville; *Lycoming County:* Roaring Branch of Lycoming Creek; *Montgomery County:* Camp Hill, Conshohocken, Henderson, King of Prussia, opposite Lafayette, Marble Hall, Rose's quarry, Spring Mill, Sumneytown; *Northampton County:* Chestnut Hill; *Philadelphia:* Prince's quarry, and Wissahickon Valley; *York County:* Emigsville, Hellam, New Holland, Spring Grove, Thomasville, Wrightsville, York Valley, and York.

ANKERITE

$Ca(Mg,Fe)(CO_3)_2$ RHOMBOHEDRAL

Color: white, gray, or reddish, weathering brown. Translucent to subtranslucent. Luster: vitreous to pearly. Form: rhombohedral crystals or aggregates of crystals; crystalline masses, coarse or fine granular. H = 3.5–4. Sp. gr. 2.95–3.1.

Composition: $Ca(Mg,Fe)(CO_3)_2$. Intermediate between calcite, magnesite, and siderite.

Analyses: A. Phoenixville Tunnel, Chester County. Transparent and colorless rhombohedra with a brown superficial coating. Sp. gr. 2.953. Koenig, 1877, 291; R. B. Chipman, analyst. B. Wheatley mines, Chester County. Yellowish-white, curved rhombohedral crystals. Genth, 1875, 157; W. P. Headden, analyst. C. Doan's Mine, New Galena, Bucks County. Edgar T. Wherry, Mineral Collector, 13, 62, 1906.

	A		B	C
CaO	28.60	$CaCO_3$	50.72	49.30
MgO	13.03	$MgCO_3$	21.98	22.65
FeO	14.41	$FeCO_3$	27.29	27.53
CO_2	44.56	Insoluble	0.22	0.42
	100.60		100.21	99.90

LOCALITIES: *Bucks County:* New Galena; *Chester County:* Downingtown, French Creek mines, Phoenixville tunnel (yellowish-white, curved rhombohedra), Wheatley mines; *Lancaster County:* Quarryville; *Montgomery County:* Ecton mine, Perkiomen mine; *Philadelphia:* Prince's quarry; *York County:* New Holland, York.

MAGNESITE

$MgCO_3$ RHOMBOHEDRAL (Tetartohedral)

Color: white, yellowish or grayish-white. Transparent to opaque. Luster: vitreous. Form: compact earthy masses, rarely fibrous or crystallized. H = 3.5–4.5. Brittle. Sp. gr. 3.0–3.12.

Composition: $MgCO_3$; MgO 47.6, CO_2 52.4, = 100. The earthy variety is often mixed with sepiolite, and adheres to the tongue.

BREUNNERITE. A white, yellowish or brownish ferriferous variety of magnesite: $(Mg,Fe)CO_3$. Sp. gr. 3–3.2. The mineral becomes brown on exposure.

Analyses: A. Goat Hill, West Nottingham, Chester County. Genth, 1875, 158; John H. Campbell, analyst. The analysis shows an admixture of 8.42% of impurities, chiefly serpentine. B. Breunnerite, Prince's quarry, Lafayette, Montgomery Co. Yellowish-white, vitreous, rhombohedral. Imbedded in steatite. Mean of 2 analyses; Leeds, 1870, 63.

	A	B
MgO	45.96	38.43
CaO	0.40	3.29
FeO	tr.	10.39
Al_2O_3	0.45	——
SiO_2	3.50	——
CO_2	47.97	47.96
H_2O	2.46	——
	100.74	100.07

LOCALITIES: *Chester County:* Brinton's quarry, Goat Hill, Paoli, Scott's chrome mine, and Taylor's quarry; *Delaware County:* Black Horse, Mineral Hill, Chrome mine. Barren Springs, Carter's chrome mine, Low's mine, Texas, and Wood's chrome mine; *Lancaster County:* Chestnut Hill; *Philadelphia:* Prince's quarry.

Breunnerite: *Montgomery County:* opposite Lafayette; *Northampton County:*

SIDERITE

$FeCO_3$ RHOMBOHEDRAL

Color: brown. Luster: vitreous. Translucent to subtranslucent. Form: rhombohedral, often aggregated into druses or botryoidal forms. H = 3.5–4. Brittle. Sp. gr. 3.83–3.88.

Crystallography: Rhombohedral; c = 0.8184; p_0 = 0.5456. Common forms: *c* (0001), *r* ($10\bar{1}1$), *e* ($01\bar{1}2$).

Composition: $FeCO_3$. FeO 62.1, CO_2 37.9, = 100.

Analysis: Dallastown, York County. Gray, massive, slightly crystalline. Genth, 1876, 229; Alfred Pearce, analyst.

$FeCO_3$	77.99
$MnCO_3$	0.45
$CaCO_3$	1.43
$MgCO_3$	3.53
Al_2O_3	2.81
SiO_2 and quartz	11.56
H_2O, and organic matter	2.23
	100.00

LOCALITIES: *Allegheny County:* Pittsburgh; *Beaver County:* New Brighton; *Berks County:* Bernhards, Weaver mine; *Chester County:* Doe Run quarries, French Creek mines; five miles southwest of Nottingham, Unionville, and Wheatley mines; *Clarion County:* Mechanicsville; *Delaware County:* Leiperville, Ward's quarry; *Fayette County:* Dunbar; *Lancaster County:* Gap mine, Pequa mines; *Lehigh County:* Alburtis; *Lackawanna County:* Scranton; *Lycoming County:* Roaring Branch of Lycoming Creek; *Montgomery County:* Spring Mill; *Philadelphia:* Prince's quarry; *Schuylkill County:* Pottsville; *York County:* Dallastown, New Holland, York.

RHODOCHROSITE

$MnCO_3$ RHOMBOHEDRAL

Color: red. Streak: white. Luster: vitreous. Translucent. Form: rhombohedral cleavage masses, granular or columnar aggregates. H = 3.5–4.5. Brittle. Sp. gr. 3.45–3.60.

Composition: $MnCO_3$; MnO 61.7, CO_2 38.3.

LOCALITIES: *Chester County:* French Creek mines; *Lebanon County:* Cornwall.

SMITHSONITE

$ZnCO_3$ RHOMBOHEDRAL

Color: white, grayish, greenish, blue, or brown. Streak: white. Subtransparent to translucent. Luster: vitreous inclining to pearly. Form: stalactitic, botryoidal, reniform, granular or earthy masses; rarely crystallized. H = 5. Brittle. Sp. gr. 4.30–4.45.

Composition: $ZnCO_3$; ZnO 64.8, CO_2 35.2, = 100. Fe, Mn, Ca, or Mg may replace Zn, and rarely Cd is present.

LOCALITIES: *Blair County:* Keystone zinc mine near Birmingham; *Chester County:* Wheatley mines; *Lancaster County:* Bamford; *Lehigh County:* Friedensville; *Montgomery County:* Perkiomen mine; *York County:* York.

ARAGONITE

$CaCO_3$ ORTHORHOMBIC

Colorless, white, yellow. Transparent to translucent. Luster: vitreous. Form: acicular crystals; columnar, radiating, stalactitic, incrusting. H = 3.5–4. Sp. gr. 2.93–2.95.

Crystallography; Orthorhombic; a : b : c = 0.6224 : 1 : 0.7206.

$p_0 : q_0 : r_0 = 1.1578 : 0.7206 : 1.$

Common forms: *m* (110), *b* (010), *k* (011); twin plane *m* (110). Cleavage: *b* distinct, *m* and *k* imperfect.

Composition: $CaCO_3$; CaO 56.0, CO_2 44.0, =100.

Analyses: A. Opposite Mt. Union, Mifflin County. White fibrous seams and crusts. Genth, 1876, 229. B. Zinciferous. Friedensville, Lehigh County. White and yellowish-white, radiating groups of crystals; Genth, 1875, 163; analyst, W. Theo. Roepper.

	A	B
$CaCO_3$	98.09	94.20
$SrCO_3$	0.58	——
$ZnCO_3$	——	4.73
SiO_2, Fe_2O_3, etc.	1.00	——
Insoluble	——	0.53
H_2O (by diff.)	0.33	——
	100.00	99.46

LOCALITIES: *Allegheny County:* Pittsburgh; *Berks County:* Crystal Cave, Fritz Island, Jones mine, Ruth mine, Wheatfield mines; *Chester County:* Avondale, Brinton's quarry, Byers, French Creek mines; Knickerbocker quarry, Marshall's quarry, Nevin's quarry, Pusey's quarry, Tyler's quarry, and the Wheatley mines; *Lancaster County:* Lancaster, and Wood's chrome mine; *Lebanon County:* Cornwall; *Lehigh County:* Friedensville (zinciferous); *Mifflin County:* opposite Mt. Union; *Montgomery County:* Lansdale, Pottstown, Rose's quarry, West Conshohocken; *Northampton County:* Chestnut Hill; *York County:* New Holland.

STRONTIANITE

$SrCO_3$ ORTHORHOMBIC

Color: white, gray, yellow, greenish. Streak: white. Transparent to translucent. Luster: vitreous, inclining to resinous on fractured surfaces. Form: columnar, fibrous; acicular crystals. H = 3.5–4. Sp. gr. 3.680–3.714.

Composition: $SrCO_3$; SrO 70.1, CO_2 29.9, = 100.

Analysis: Opposite Mt. Union, Mifflin County. White, minute acicular crystals with aragonite. Genth, 1876, 229.

$CaCO_3$	15.36
$SrCO_3$	83.15
MgO	0.38
SiO_2, Fe_2O_3, etc.	0.50
H_2O (by diff.)	0.61
	100.00

LOCALITY: *Mifflin County:* opposite Mt. Union, in Lewistown limestone.

CERUSSITE

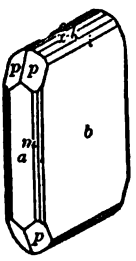
$PbCO_3$ ORTHORHOMBIC

Colorless, white, gray, blue, grayish-black. Streak uncolored. Transparent to subtranslucent. Luster: adamantine inclining to vitreous, resinous or pearly. Form: tabular crystals, usually twinned; fibrous or reticulated masses. H = 3–3.5. Very brittle. Sp. gr. 6.46–6.574.

Crystallography: Orthorhombic; a : b : c = 0.6100 : 1 : 0.7230.

$p_0 : q_0 : r_0 = 1.1853 : 0.7230 : 1.$

Forms: *a* (100), *b* (010), *c* (001), *m* (110), *r* (130), *x* (012), *k* (011), *i* (021), *v* (102), *p* (111); Wheatley mine, Chester County (Dana, 1892, 286; Rogers, 1902, 136). Twins common, twin plane *m* (110), contact and penetration twins. Simple crystals are usually tabular parallel to *b* (010). Cleavage: *m* and *i* distinct, *b* and *x* in traces. Fracture: conchoidal.



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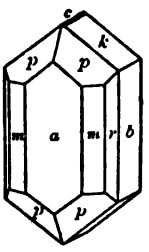

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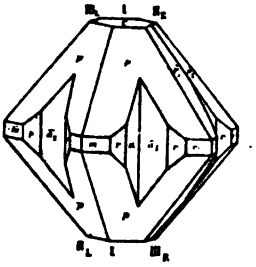

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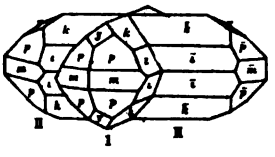

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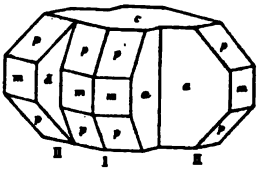

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Figs. 36–40. Cerussite, Wheatley mines (36 and 37, *Dana;* 38–40, *Schrauf*).

Composition: $PbCO_3$; PbO 83.5, CO_2 16.5, = 100.

Analysis: Wheatley Mine, Chester County. Transparent, colorless crystals. Sp. Gr. 6.60. J. L. Smith, 1855, 248.

PbO	83.76
CO_2	16.38
	100.14

LOCALITIES: *Blair County:* Keystone zinc mine near Birmingham; *Bradford County:* Carpenter mine (New Albany); *Berks County:* Jones mine; *Chester County:* Charlestown mine, Morris mine, Wheatley mines (colorless, white, yellow, and black crystals, commonly twinned; twinned crystals measure up to 5 cm. in breadth, individuals measure up to 3×1.5 cm.); *Clearfield County:* Clearfield Creek; *Lancaster County:* Bamford mine, Pequa mines; *Montgomery County:* Ecton mine, Perkiomen mine.

MALACHITE

$Cu_2(OH)_2CO_3$ MONOCLINIC

Color: emerald-green. Translucent to subtranslucent to opaque. Luster: adamantine to vitreous. Form: fibrous mammillary or botryoidal stalactites; tufts or rosettes of acicular crystals. H = 3.5–4. Brittle. Sp. gr. 3.9–4.03.

Crystallography: Monoclinic; a : b : c = 0.7823 : 1 : 0.4036, $\beta = 91°3'$.

$p_0 : q_0 : r_0 = 0.5159 : 0.4035 : 1, \mu = 88°57'$.

Forms: *c* (001), *a* (100), *b*(010), and *m* (110). Habit: prismatic. Cleavage: *c* perfect, *b* less so.

Composition: $CuCO_3.Cu(OH)_2$; CuO 71.9, CO_2 19.9, H_2O 8.2, = 100.

Analysis: Wheatley mines, Chester County. Green, fibrous; Sp. gr. 4.06. Smith, 1855, 249. An old analysis by Mitchell, 1813, 125, is omitted. This was one of the first analyses made by an American chemist, but is of historic interest only.

CuO	71.46
Fe_2O_3	0.12
CO_2	19.09
H_2O	9.02
	99.69

LOCALITIES:[37] *Adams County:* Gettysburg, Hamiltonban; *Bradford County:* Carpenter mine (New Albany); *Berks County:* Fritz Island, Jones mine (large fibrous masses, of beautiful radiating structure), east of Poplar Neck, Snyderville, and Wheatfield mines; *Bucks County:* Buckmanville, Finney's quarry, Holland, Keelersville, New Galena, Nockamixon, Sellersville, Solebury mine, Uhlertown, and Vanartsdalen's quarry; *Chester County:* Corundum Hill (Newlin), French Creek mines, and Wheatley mines; *Delaware County:* Avondale; *Lancaster County:* Glenwood Station; *Lebanon County:* Cornwall; *Lehigh County:* Friedensville, and South Mountain; *Montgomery County:* Arcola (large masses), Collegeville (traces), Ecton mine, Gilbertville (traces), Graters Ford, Henderson, Hendricks Station, Langfield, Lansdale, Lederachsville (traces), Marble Hall, Mogeetown, Pennsburg Station (traces), Perkiomen mine, Pottstown, Schwenksville, Port Kennedy, Shainline (crystals), Shannonville copper mine, Sumneytown; *Northampton County:* Leithsville; *Philadelphia:* Fairmount Park, Frankford, Germantown, O'Neill's quarry, Prince's quarry, Rittenhouse quarry; *Pike County:* Poxono Island; *Wyoming County:* Nicholson township; *York County:* Franklintown, Wellsville, York Valley.

AZURITE

$Cu_3(OH)_2(CO_3)_2$ MONOCLINIC

Color: azure-blue. Streak: lighter blue. Transparent to subtranslucent. Luster: vitreous. Form: tabular crystals, usually in drusy coatings. H = 3.5–4. Sp. gr. 3.77–3.83.

Crystallography: Monoclinic; $a : b : c = 0.8502 : 1 : 0.8805$; $\beta = 92°24'$.

$p_0 : q_0 : r_0 = 1.0357 : 0.8797 : 1$; $\mu = 87°36'$.

Forms: *a* (100), *c* (001), *m* (110), *o* (101), *h* (221), *p* (021). Cleavage: *p* (021) perfect but interrupted; *c* less perfect.

Composition: $2CuCO_3.Cu(OH)_2$; CuO 69.2, CO_2 25.6, H_2O 5.2, = 100.

Analysis: Wheatley mines, Chester County. Sp. gr. 3.88; Smith, 1855, 250.

CuO	69.41
CO_2	24.98
H_2O	5.84
	100.23

LOCALITIES: *Adams County:* Hamiltonban; *Berks County:* Fritz Island; *Bucks County:* Finney's quarry; *Chester County:* Wheatley mines (brilliant blue crystals measuring up to 1.75 cm.); *Lancaster County:* Glenwood Station, Reinhold's Station; *Lebanon County:* Cornwall (druses of minute crystals); *Montgomery County:* Ecton mine, Graters Ford, Perkiomen mine, Sumneytown.

HYDROZINCITE

$Zn_5(OH)_6(CO_3)_2$ MONOCLINIC

Color: white, grayish or yellowish. Streak: shining white. Luster: dull, earthy or chalklike. Form: earthy, compact, or fibrous incrustations. H = 2–2.5. Sp. gr. 3.58–3.8.

Composition: $2ZnCO_3.3Zn(OH)_2$; ZnO 74.14, CO_2 16.03, H_2O 9.83, = 100.

LOCALITIES: *Lancaster County:* Bamford; *Lehigh County:* Friedensville; *Montgomery County:* Ecton mine; *York County:* York.

[37] Traces of malchite are of common occurrence in the Triassic red sandstones and shales, (Lyman, 1898, 416), and in the Catskill red shales.

AURICHALCITE

$(Zn,Cu)_5(OH)_6(CO_3)_2$ MONOCLINIC

Color: pale green. Translucent. Luster: pearly. Form: acicular crystals forming drusy incrustations. H = 2. Sp. gr. 3.54–3.64.

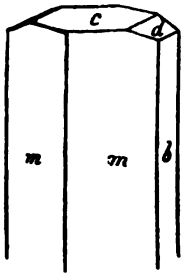
Composition: $2(Zn,Cu)CO_3.3(Zn,Cu)(OH)_2$; ZnO 53.2, CuO 20.8, CO_2 16.1, H_2O 9.9, = 100.

LOCALITIES: *Berks County:* Fritz Island, and Jones mine; *Lancaster County:* Bamford (radiating acicular crystals on dolomite); *York County:* York.

NESQUEHONITE[38]

$MgCO_3.3H_2O$ ORTHORHOMBIC

Colorless, gray or white; transparent to almost opaque. Luster: vitreous to silky. Form: prismatic crystals; fibrous, bladed masses; cryptocrystalline chalk-like pseudomorphs after lansfordite. H = 2.5. Sp. gr. 1.83–1.85.



41

Fig. 41. Nesquehonite, Nesquehoning, Carbon County (*Penfield*).

Crystallography: Orthorhombic;

$$a : b : c = 0.645 : 1 : 0.4568;$$

$$p_0 : q_0 : r_0 = 0.7082 : 0.4568 : 1.$$

Forms: *c* (001), *b* (010), *m* (110), and *d* (011). Habit: prismatic. Prismatic zone deeply striated parallel to the c axis. Cleavage: *m* perfect, *c* less perfect. Optically–; axial plane parallel to c. $Bx_{Aa} \perp c$. $2E_{Li} = 83°55'$, $2E_{Na} = 84°15'$, $2E_{Tl} = 84°22'$. Double refraction strong.

Composition: $MgCO_3.3H_2O$; MgO 29.0, CO_2 31.4, H_2O 39.1, = 100.

Analyses: Nesquehoning, Carbon County. A. Best crystals. B. Altered stalactites (pseudomorphs after lansfordite); opaque white, radiating, fibrous. Genth and Penfield, 1890, 125.

	A	B
MgO	29.22	28.23
CO_2	30.22	28.85
H_2O	40.32	42.92
	99.76	100.00

LOCALITY: *Carbon County:* Nesquehoning; on the walls and roof of the No. 1 Tunnel, adjacent to the "Fifty-foot Vein" about 2000 feet from the entrance.

LANTHANITE

$(La_2,Ce_2)(CO_3)_3.8H_2O$ ORTHORHOMBIC

Color: delicate pink. Transparent. Luster: pearly or dull. Form: thin tabular four-sided plates or beveled tables. H = 2.5–3. Sp. gr. 2.605.

Crystallography: Orthorhombic;

$$a : b : c = 0.9528 : 1 : 0.9023;$$

$$p_0 : q_0 : r_0 = 0.9470 : 0.9023 : 1.$$

Forms: *a* (100), *c* (001), *m* (110), *o* (111). Habit: tabular parallel to *c* (001).

Analyses: Friedensville, Lehigh County. A. Blake, 1853, 230; analysis by Smith. B. Smith, 1854, 378. C. Genth, 1857, 425.

	A	B	C
La_2O_3, Ce_2O_3, etc.	54.90	55.03	54.95
CO_2	22.58	21.95	21.08
H_2O	24.09	24.21	(23.97)
	101.57	101.19	100.00

LOCALITY: *Lehigh County:* Friedensville. A mass of delicate pink tabular crystals was found in an ochery soil a few feet below the surface in sinking a shaft. The occurrence probably represented a weathered erratic boulder of allanite.

[38] F. A. Genth and S. L. Penfield, On lansfordite, nesquehonite, a new mineral, and pseudomorphs of nesquehonite after lansfordite. Am. J. Sci., (3) 39, 121–137, 1890.

HYDROMAGNESITE

$Mg_4(OH)_2(CO_3)_3.3H_2O$ ORTHORHOMBIC

Colorless to white. Luster: vitreous, silky, subpearly, or earthy. Form: small acicular, tabular or bladed crystals, often in tufted aggregates; amorphous chalky or mealy masses. H =3.5. Brittle. Sp. gr. 2.145–2.18.

Crystallography: Orthorhombic:

$$a : b : c = 1.0379 : 1 : 0.4652.$$

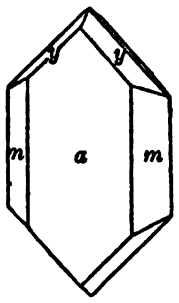
$$p_0 : q_0 : r_0 = 0.4482 : 0.4652 : 1.$$

Forms: *a* (100), *m* (110), and *y* (121); Wood's chrome mine, Lancaster County, (Dana, 1854, 84).

Composition: $3MgCO_3.Mg(OH)_2.3H_2O$; MgO 43.9, CO_2 36.3, H_2O 19.8 = 100.

Lancasterite is a mixture of brucite and hydromagnesite described by Silliman, Jr., 1850, 216 (see Smith and Brush, 1853, 214).

Analyses: Wood's mine, Lancaster County. A–D. Radiating crystals. Smith and Brush, 1853, 214. E. "Lancasterite" a mixture of foliated brucite and radiated hydromagnesite. Silliman, Jr., 1850, 216, mean of 2 analyses by H. Erni.



42

Fig. 42. Hydromagnesite, Texas, Lancaster County (*Smith and Brush*).

	A	B	C	D	E
MgO	42.30	44.00	43.20	42.51	50.36
FeO	tr.	tr.	tr.	tr.	0.99
MnO	tr.	tr.	tr.	tr.	——
CO_2	36.74	36.60	36.69	35.70	26.96
H_2O	20.96	19.40	20.11	21.79	21.53
	100.00	100.00	100.00	100.00	99.84

LOCALITIES: *Berks County:* Ruth mine? *Lancaster County:* Carter's mine, Low's mine, and Wood's chrome mine (druses of acicular crystals and radiated masses); *Northampton County:* Chestnut Hill?

LANSFORDITE[39]

$Mg_4(OH)_2(CO_3)_3.21\ H_2O$ TRICLINIC

Colorless to white. Translucent, resembling paraffin. Luster: vitreous to waxy. Form: stalactites terminated with crystal faces. H = 2.5. Sp. gr. 1.54–1.692.

Crystallography: Triclinic.

$$a : b : c = 0.5493 : 1 : 0.5655;\ \alpha = 95°22',\ \beta = 100°15',\ \gamma = 92°28'.$$

$$p_0 : q_0 : r_0 = 1.0259 : 0.4974 : 1;\ \lambda = 84°6',\ \mu = 79°28',\ \nu = 86°31'.$$

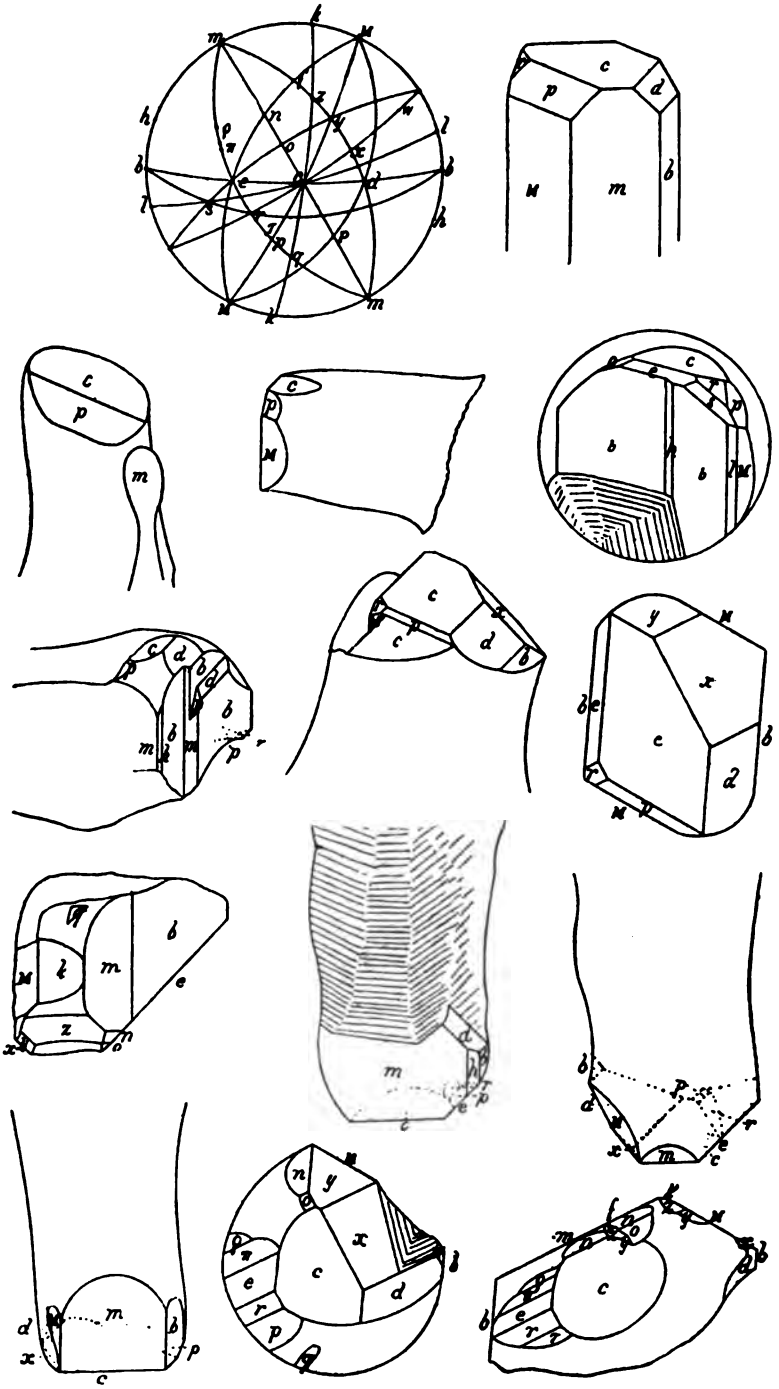
Forms: *b* (010), *c* (001), *m* (110), *h* (150), *k* (310), M ($1\bar{1}0$), *l* ($1\bar{1}0$), *f* ($\bar{2}01$), *d* (021), *e* ($0\bar{2}1$), P (111), *y* ($\bar{1}11$), *s* (312), *x* ($\bar{1}32$), *w* ($\bar{5}.15.1,$) *o* ($\bar{1}12$), *n* ($\bar{1}11$), *ρ* ($\bar{1}31$), *π* ($\bar{1}52$), *q* ($3\bar{1}2$), *τ* ($10.\bar{1}2.11$), *r* ($\bar{1}32$), *s* ($\bar{1}72$). Twins are not uncommon. (Genth and Penfield, 1890, 128; the above measurements were made of pseudomorphs of nesquehonite after lansfordite).

Composition: $3MgCO_3.Mg(OH)_2.21\ H_2O$; MgO 23.2, CO_2 19.2, H_2O 57.6, = 100. The mineral rapidly dehydrates in the air, turning into chalk-white, opaque nesquehonite; it is probably possible to preserve them in petroleum oil.

Analysis: Nesquehoning, Carbon County. Colorless, waxy, translucent crystal-stalactites. Sp. gr. 1.54–1.692. Genth, 1888, 255; Frank J. Keeley, analyst.

MgO		23.18
CO_2		18.90
H_2O lost over H_2SO, 20 hours	4.83	
H_2O lost over H_2SO, 48 hours	11.70	
H_2O lost over H_2SO, 1 week	26.33	57.79
H_2O lost at 110°C	12.31	
H_2O lost at 185°C	9.76	
H_2O lost at red heat	9.36	
		99.87

[39] Genth, 1888, 255; Genth and Penfield, 1890, 128; see also Federov, 1906, 299.



Figs. 43–56. Lansfordite, Nesquehoning, Carbon County (*Penfield*).

LOCALITY: *Carbon County:* Nesquehoning, on the walls and roof of the No. 1 Tunnel, adjacent to the "Fifty-foot Vein," about 2000 feet from the entrance.

ZARATITE[40]

$Ni_3(OH)_4CO_3.4H_2O$ AMORPHOUS

Color: emerald-green. Streak paler. Transparent to translucent. Luster: vitreous. Form: incrusting; massive, compact, stalactitic or mammillary. H = 3–3.25. Brittle. Sp. gr. 2.57–2.68.

Composition: $NiCO_3.2Ni(OH)_2.4H_2O$; NiO 59.6, CO_2 11.7, H_2O 28.7, = 100.

Analyses: Wood's mine, Lancaster County. A. Smith and Brush, 1853, 52. B. Silliman, Jr., 1848, 249. An erroneous analysis of a mixture by Garrett, 1853, 333, is omitted.

	A	B
NiO	56.82	58.81
MgO	1.68	——
CO_2	11.63	11.69
H_2O	29.87	29.50
	100.00	100.00

LOCALITIES: *Chester County:* Moro Phillip's chrome mine (West Nottingham); *Lancaster County:* Carter's chrome mine, Low's mine, and Wood's chrome mine.

BISMUTITE

$Bi_2CO_6.5H_2O$? AMORPHOUS?

Color: white, greenish or yellow. Luster: vitreous or dull. Subtranslucent to opaque. Form: earthy coatings. H = 4. Sp. gr. 7.

LOCALITIES: *Delaware County:* Avondale; Crozer's quarry in Chester.

RANDITE

$Ca_2U_3(CO_3)_5.6H_2O$?

Color: canary or lemon-yellow. Translucent. Luster: vitreous. Form: incrustations of yellow needles. H = 2–3.

Analyses: South end of quarry at Frankford, northeast of Adams Street, Philadelphia. A. Analysis of 47 mg. of material. Koenig, 1878, 409. This analysis is of a mixture of calcite and randite. B. Rand, 1880, 275. Partial analysis of acicular crystals of randite after calcite was removed by acetic acid.

	A	B
CaO	32.50	16.71
$Al_2(PO_4)_2$?	——	0.89
U_3O_3	31.63	46.71
H_2O	6.53	
CO_2 (by diff.)	(29.34)	
	100.00	

LOCALITY: *Philadelphia:* Frankford.

SILICATES

Feldspar Group

ORTHOCLASE	$KAlSi_3O_8$	Monoclinic
HYALOPHANE	$(K_2,Ba)Al_2Si_4O_{12}$	Monoclinic
MICROCLINE	$KAlSi_3O_8$	Triclinic
ANORTHOCLASE	$(Na,K)AlSi_3O_8$	Triclinic
ALBITE	$NaAlSi_3O_8$	Triclinic
OLIGOCLASE	$mNaAlSi_3O_8$	Triclinic
ANDESINE	$nCaAl_2Si_2O_8$	Triclinic
LABRADORITE		Triclinic
ANORTHITE	$CaAl_2Si_2O_8$	Triclinic

[40] Silliman, Jr., 1847, 407; 1848, 248.

ORTHOCLASE

$KAlSi_3O_8$ MONOCLINIC

Colorless, white, pale yellow, flesh-red, gray. Streak: uncolored. Luster: vitreous, on cleavage surface often pearly. Transparent to translucent. Form: crystals and cleavage masses. H = 6. Brittle. Sp. gr. 2.57.

Crystallography: Monoclinic;

$$a:b:c = 0.6585:1:0.5554,\ \beta = 116°\,3'$$

$$p_0:q_0:r_0 = 0.8434:0.4990:1,\ \mu = 63°\,57'.$$

Common forms: *c* (001), *b* (010), *x* ($\bar{1}01$), *y* ($\bar{2}01$), *m* (110), *z* (130), *o* ($\bar{1}11$), *n* (021). Habit: elongated || a axis, c axis, or tabular || *b* (010). Twinning common: penetration twins, twin axis c (Carlsbad law), composition face *b* (010); twin plane *n* (021) (Baveno law); twin plane *c* (001) (Manebach law). Cleavage: *c* perfect, *b* less so, *m* imperfect.

Composition: $KAlSi_3O_8$; SiO_2 64.7; Al_2O_3 18.4, K_2O 16.9 = 100.

Varieties: Adularia: colorless crystals. Necronite: cleavable, fetid orthoclase. Lennilite or Delawarite:[41] a dull bluish-green sub-transparent variety from Lenni, Delaware County; Cassinite:[42] an intergrowth of orthoclase, albite and hyalophane from Blue Hill, Delaware County; color: dull bluish-green, semi-transparent, vitreous, laminated.

Analyses: A. Adularia, Upper Avondale, Delaware County. Genth, 1883, 393. B. Weygadt, Easton, Northampton County. Eyerman, 1904, 45. C. Rocksville, Bucks County. Light green crystals. Eyerman, 1911, 3. D. French Creek mines, Chester County. Reddish-white to flesh-red, columnar radiating aggregates of deeply striated crystals. Genth, 1885, 44. E. Seissholtzville, Berks County. Genth, 1875, 94; Wm. P. Headden, analyst.

	A	B	C	D	E
SiO_2	65.84	66.14	62.95	62.68	66.86
Al_2O_3	19.50	18.96	16.69	20.90	18.97
Fe_2O_3	——	0.62	1.40	0.23	0.62
K_2O	10.69	10.79	12.44	15.99	10.04
Na_2O	3.93	3.00	6.94	none	3.61
CaO	tr.	——	——	0.15	1.41
BaO	0.08	——	——	——	——
MgO	——	——	——	——	tr.
Ignition	0.22	0.40	0.20	0.67	——
	100.26	99.91	100.62	100.62	101.51
Sp. gr.	2.595	2.597	2.576	2.528	

	F	G	H	I	J
SiO_2	65.77	63.48	62.95	62.60	64.20
Al_2O_3	19.21	20.14	19.82	19.97	19.69
Fe_2O_3	0.26	1.31	0.17	0.12	0.69
K_2O	9.11	9.42	8.57	8.95	9.59
Na_2O	4.88	4.98	4.01	4.31	3.43
CaO	0.16	——	0.25	0.19	2.27
BaO	0.57	——	3.95	3.71	——
SrO	——	——	——	tr.	——
MgO	tr.	——	——	——	0.15
MnO	tr.	——	——	——	——
Ignition	0.20	0.35	0.11	0.19	0.27
	100.16	99.68	99.83	100.04	100.29
Sp. gr.	2.619	2.569			

[41] Lea (1866, 110)

[42] Lea (1866, 110); Penfield and Sperry (1888, 326).

F. "Lennilite," "Delawarite." Greenish or grayish-white, with a vitreous or pearly luster. Lenni, Delaware County. Genth, 1876, 224. G. "Lennilite." Lenni, Delaware County. Eyerman, 1911, 3. H. "Cassinite." An intergrowth of orthoclase, albite and hyalophane. Dull bluish-green, semi-transparent cleavage masses. Penfield and Sperry, 1888, 326. Blue Hill, Delaware County. I. "Cassinite." Average of 3 analyses by Genth, 1876, 224. Blue Hill, Delaware County. J. "Cassinite." Blue Hill, Delaware County. Leeds, 1870, 63. BaO was overlooked.

LOCALITIES:[43] *Berks County:* Antietam Reservoir, Huff Church, Mt. Penn, Siessholtzville, Stony Creek Mills; *Bucks County:* Finney's quarry, Johnson's graphite mine, Vanartsdalen's quarry (necronite); *Chester County:* Bailey's quarry (necronite), Sylmar, Cope's quarry (necronite), Corundum Hill? French Creek mines, Fremont, Hopewell mines, Magnesia quarry, Mendenhall's quarry (necronite), Nevin's quarry (necronite), Osborn Hill, Sadsburyville, Scott's chrome mine, Warwick mines; *Delaware County:* Avondale (adularia), Blue Hill (cassinite and delawarite), Brandywine Summit, Franklin Paper Mill, Lenni (delawarite), Mineral Hill (aventurine, and delawarite), Sycamore Mills (cassinite), Ward's quarry, and Yarnall's farm in Edgemont (cassinite); *Lancaster County:* Pequa mines (adularia), and Quarryville; *Montgomery County:* Gladwyne (adularia); *Northampton County:* Chestnut Hill, and Redington; *Philadelphia:* Branchtown, Cobb's Creek, Fairmont Park, Hestonville, south of Lafayette, O'Neill's quarry, Overbrook (porphyritic crystals in gneiss showing carlsbad twinning).

MICROCLINE

$KAlSi_3O_8$ TRICLINIC

Color: flesh-red, cream-yellow, green, white. Transparent to translucent. Luster: vitreous, sometimes pearly on *c*. Form: crystals and cleavage masses. H = 6–6.5. Brittle. Sp. gr. 2.54–2.57.

Crystallography: Triclinic. Forms: *a* (100), *b* (010), *c* (001), *m* (110), M ($1\bar{1}0$), *f* (130), *z* ($1\bar{3}0$), *x* ($\bar{1}01$), *y* ($\bar{2}01$), *h* ($\bar{3}01$), *p* ($\bar{1}11$), *σ* ($\bar{4}43$), *g* ($\bar{2}21$), and *o* ($\bar{1}11$). Twinning common, like orthoclase, according to the Carlsbad, Baveno, and Manebach laws. Cleavage: *c* perfect, *b* less so, *m* and M sometimes distinct.

Composition: $KAlSi_3O_8$; SiO_2 64.7, Al_2O_3 18.4, K_2O 16.9, = 100. Na is usually present. Varieties: Amazonstone,—bright verdigris green. Chesterlite,[44]—white, smooth, feebly lustrous crystals from the Poorhouse quarry, West Bradford, Chester County.

Analyses: A. Upper Avondale, Delaware County; flesh red; Genth, 1882, 393; analysis, by Genth, Jr. B. Upper Avondale, Delaware County; white cleavage masses; Genth, 1883, 393. C. Johnson's quarry, Elam, Delaware County; Eyerman, 1911, 3–4. D. Amazonstone, Mineral Hill, Delaware County; Descloizeaux, 1876, 433–465; analysis by Pisani.

	A	B	C	D
SiO_2	64.53	65.03	65.38	64.90
Al_2O_3	19.64	19.22	18.92	20.92
Fe_2O_3	tr.	——	0.77	0.28
K_2O	13.62	14.18	12.37	10.95
Na_2O	1.77	1.71	1.98	3.95
CaO	0.16	0.32	——	——
MgO	0.25	——	——	——
MnO	——	tr.	——	——
P_2O_5	——	0.08	——	——
Ignition	0.71	0.13	0.45	0.20
	100.68	100.67	99.87	101.20
Sp. gr.	2.555	2.572	2.571	2.57

[43] Some of the occurrences listed above may be microcline.

[44] Dana (1850, 651); Breithaupt (1858, 1); Smith and Brush (1853, 42); Lea (1866, 113); Descloizeaux (1876, 433, 461, 463, 465).

E. "Chesterlite." Poorhouse quarry, West Bradford, Chester County. Smith and Brush, 1853, 42. Sp. gr. 2.513 (B. Silliman, Jr.). F. "Chesterlite." Smith and Brush, 1853, 42. G. Vanartsdalen's quarry, Bucks County. Dark gray to bluish, opalescent cleavage masses, distinctly striated; so-called "labradorite." Genth, 1876, 225. H. Vanartsdalen's quarry, Bucks County. White crystals. Eyerman, 1911, 3–4.

	E	F	G	H
SiO_2	64.76	65.17	64.93	62.45
Al_2O_3	17.60	17.70	18.58	16.22
Fe_2O_3	0.50	0.50	0.49	0.54
K_2O	14.18	13.86	10.44	14.88
Na_2O	1.75	1.64	3.04	4.95
CaO	0.65	0.56	1.77	0.52
MgO	0.30	0.25	0.12	—
Ignition	0.65	0.65	1.11	0.91
	100.39	100.33	100.48	100.47
Sp. gr.	2.513		2.497	2.581

LOCALITIES: *Bucks County:* Newportville, Vanartsdalen's quarry (blue, opalescent); *Chester County:* Avondale, Bailey's farm (East Marlboro), Johnson and Patterson's quarry (Newlin), Poorhouse quarry (chesterlite), Pusey's quarries, Toughkenamon, and Swayne's farm (Pennsbury); *Delaware County:* Adele, Avondale (pink crystals), Black Horse, Boothwyn (crystals up to 30 cm. in length), Brandywine Summit, Bunting's quarry, Burk's quarry, Chelsea, Chester Heights, Crossbyville, Crozer's quarry, Edgemont, Darby, Evan's farm (Middletown), Gillespie's quarry, Green's farm near Upland, Haverford township, Henvi's quarry, Irving's quarry, Kellyville, Leiperville, Lenni, Mineral Hill (amazonstone), Morgan Station, Morton, Shaw and Esrey's quarry in Chester, Sharpless' farm (Nether Providence), Sharpless' quarry, Strath Haven Inn, Sycamore Mills, Trainer, Ward's quarry, and Worrall's farm (Upper Providence); *Montgomery County:* Flat Rock tunnel, Gladwyne, Lafayette, and Wyncote; *Philadelphia:* Chestnut Hill, Cobb's Creek, Fairmount Park (large crystals), Falls of Schuylkill, Frankford, Germantown, Holmesburg, Logan, Manayunk, Overbrook, Rittenhouse quarry, Ryers, Shawmont, West Philadelphia, Wingohocking Creek.

ALBITE

$NaAlSi_3O_8$ TRICLINIC

Colorless, white, gray, bluish, sometimes with a blue opalescence or play of colors on *c* (moonstone). Transparent to translucent. Luster: vitreous; on cleavage surfaces often pearly. Form: small tabular or prismatic crystals; cleavage masses, lamellar or granular. H = 6–6.5. Brittle. Sp. gr. 2.62–2.65.

Crystallography: Triclinic.

$a:b:c = 0.6187:1:0.5641$; $\alpha = 93° 42'$, $\beta = 116° 48'$; $\gamma = 89° 4'$.

$p_0:q_0:r_0 = 0.9099:0.5035:1$; $\lambda = 86° 20'$, $\mu = 63° 12'$, $\nu = 89° 11'$.

Common forms: *c* (001), *b* (010), *m* (110), *z* ($1\bar{1}0$), *x* ($\bar{1}01$), and M ($1\bar{1}0$). Twins common, according to the Carlsbad, Baveno or Manebach laws; Albite law: twin plane (010), polysynthetic giving rise to twin striations on *c*, rarely absent; Pericline law: twin axis b, polysynthetic, giving rise to striations on *b*. Habit: elongated parallel to the b axis, or tabular parallel to *b* (010). Cleavage: *c* perfect, *b* less perfect, *m* imperfect.

Composition: $NaAlSi_3O_8$; SiO_2 68.7, Al_2O_3 19.5, Na_2O 11.8, = 100.

Analyses: A. Upper Avondale, Delaware County. Colorless to white crystals. Genth, 1882, 393. B. Upper Avondale. Albite with oligoclase, cleavage mass. Genth, 1883, 393. C. Shaw and Esrey's quarry, Chester. Crystals. Genth, 1875, 92. D. Mineral Hill, Middletown, Delaware County. Penfield and Sperry, 1887, 392, analysis by Sperry. Extinction on *b* 12°, rhombic section 12°. E. Mineral Hill, Delaware County. Moonstone. Leeds, 1875, 25. F. Schofield's farm, 1/2 mile west of Elwyn Station, Delaware County. Genth, Second Geol. Surv. Penna., C5, 1885, 116.

	A	B	C	D	E	F
SiO_2	68.52	65.22	68.03	66.34	67.70	66.24
Al_2O_3	19.44	21.44	20.23	20.72	19.98	20.91
Fe_2O_3	——	0.20	tr.	——	tr.	tr.
K_2O	0.65	1.16	0.09	0.98	1.36	1.12
Na_2O	11.42	9.36	10.81	9.44	8.86	10.14
CaO	——	2.07	0.48	1.85	1.47	1.61
MgO	——	——	——	——	0.11	——
MnO	——	tr.	——	——	——	——
Ignition	——	0.58	0.62	0.38	0.08	0.59
	100.03	100.03	100.26	99.71	99.56	100.61
Sp. gr.	2.694	2.620		2.627	2.59	

G. Lenni, Delaware County. G. M. Lawrence; Second Geol. Surv. Penna. Rep., C5, 1885, 116. H. S. Dana's farm, near Morrisville, Bucks County. Genth, Second Geol. Surv. Penna. Rep., C6, 101, 1881. I. Unionville, Chester County. White "oligoclase." Smith and Brush, 1853, 211; mean of 2 analyses. J. Unionville, Chester County. Crystalline. Silliman, Jr., 1849, 390; analysis by Weld. K. Unionville, Chester County. Crystalline. Boyé 1841, 190. L. Lancaster County; chrome mine. Grayish-white, granular. Silliman, Jr., 1849, 390; analysis by Brush. M. "Pennsylvania." Redtenbacker, Pogg. Annal., LII, 49 (Genth, 1875, 92).

	G	H	I	J	K	L	M
SiO_2	65.43	67.01	64.27	66.85	67.72	66.65	67.20
Al_2O_3	20.70	19.44	21.21	21.89	20.54	20.79	19.64
Fe_2O_3	——	0.52	tr.	——	tr.	——	——
K_2O	0.70	0.30	1.36	——	0.16	——	1.58
Na_2O	9.85	10.48	10.94	8.78	10.65	9.36	9.91
CaO	1.11	1.71	0.81	1.79	0.78	2.05	1.44
MgO	0.68	0.24	0.58	0.48	0.34	0.52	0.31
Ignition	1.71	0.53	1.08	0.48	——	——	——
	100.18	100.23	100.25	100.27	100.19	99.37	100.08
Sp. gr.			2.61		2.612	2.619	

LOCALITIES: *Berks County:* Gilbert's ore pit; opposite Fritz Island, and Siessholtzville; *Bucks County:* Finney's quarry, Morrisville, and Janney; *Chester County:* Bailey's farm (East Marlboro), Copesville, Corundum Hill (Newlin), Fremont, Goat Hill, Minorcus Hill, Mt. Rocky Meeting House (East Nottingham); *Delaware County:* Avondale (colorless or white crystals forming druses in pegmatite, with muscovite and beryl), Bain's quarry, Black Horse (moonstone), Boothwyn, Darby, Franklin Paper Mills, Glen Mills, Haverford township, Leiperville, Lenni (moonstone), Mineral Hill (moonstone), Morton, Shaw and Esrey's quarry, Smedley's quarry, Sycamore Mills (moonstone), and Ward's quarry; *Montgomery County:* Flat Rock tunnel, and Wyncote; *Philadelphia:* Fairmount Park, Frankford, Germantown, Holmesburg, Logan, O'Neill's quarry, Prince's quarry, Rittenhouse quarry, Shawmont, West Philadelphia, and Wingohocking Creek.

OLIGOCLASE

$\left\{\begin{matrix} 6\text{–}3NaAlSi_3O_8 \\ 1\ CaAl_2Si_2O_8 \end{matrix}\right.$ TRICLINIC

Colorless, white, grayish, green, reddish; sometimes aventurine (sunstone). Transparent to substranslucent. Luster: vitreous to pearly or waxy. Form: commonly massive, cleavable to compact; rarely in distinct crystals. H = 6–7. Brittle. Sp. gr. 2.65–2.67.

Analyses: A. Frankford, Philadelphia. Pale greenish-white, striated, occurring with orthoclase in pegmatites. Genth, 1876, 223. B—C. Lafayette, Montgomery County. Pale bluish, with chlorite, talc, garnet, and ilmenite. Genth, 1876, 223. D. Blue Hill, Delaware County. White, striated, with cassinite. Genth, 1876, 223. E. Painter's farm, Dismal Run, Middletown, Delaware County. Transparent cleavages. Genth, 1875, 90, analysis by R. Haines.

	A	B	C	D	E
SiO_2	63.63	61.82	62.55	64.51	63.54
Al_2O_3	22.79	25.52	25.43	21.54	22.96
Fe_2O_3	——	0.47		0.05	0.16
FeO	0.43	——	——	——	——
MnO	——	0.04	n. det.	——	——
MgO	0.09	0.22	n. det.	——	——
CaO	5.51	1.81	1.87	3.31	4.21
BaO	——	——	——	0.10	——
K_2O	0.75	2.40	n. det.	1.25	0.59
Na_2O	6.87	8.03	n. det.	9.37	8.44
Ignition	0.42	1.43	n. det.	0.32	0.52
	100.49	101.74		100.45	100.42
Sp. gr	2.712	2.670		2.658	2.68

F. Mineral Hill, Middletown, Delaware County. Descloizeaux, 1884, 273; analysis by Pisani. Extinction: on *c* 1° 45′, on *b* 6°–9°; 2Hr 92°–92° 48′. G. Black Horse, Middletown, Delaware County, Genth, 1882, 384, mean of 2 analyses. H. Black Horse, Middletown, Delaware County. Genth, Second Geol. Surv. Penna. Rep., C5, 1885, 116. I—J. Brinton's quarry, Chester County. Almost colorless, vitreous. Genth, 1876, 223.

	F	G	H	I	J
SiO_2	63.20	58.42	58.62	61.04	61.65
Al_2O_3	23.60	23.14	23.55	24.25	24.13
Fe_2O_3	——	0.18	0.17	0.07	
MnO	——	tr.	——	——	——
MgO	1.53	0.35	0.46	0.29	0.28
CaO	3.56	3.13	3.23	5.05	5.25
BaO	——	2.56	2.54	——	——
SrO	——	tr.	——	——	——
K_2O	0.90	7.06	7.06	0.58	n. det.
Na_2O	7.30	3.68	3.68	7.92	n. det.
Ignition	1.20	1.54	1.49	0.54	n. det.
	101.29	100.06	100.80	99.74	
Sp. gr	2.64	2.611		2.689	

K. Unionville, Chester County. With corundum. Genth, 1882, 384. L. Unionville, Chester County. Brownish-white. Genth, 1873, 361, analysis by Thomas M. Chatard. M. Vanartsdalen's quarry, Bucks County. Genth, Second Geol. Surv. Penna. Rep. C6, 1881, 104.

	K	L	M
SiO_2	62.62	59.35	62.58
Al_2O_3	22.59	24.16	23.27
Fe_2O_3	0.22	0.61	0.23
MgO	0.18	0.34	0.15
CaO	1.94	3.08	4.88
K_2O	2.52	3.78	1.04
Na_2O	7.41	7.22	8.05
Ignition	2.45	1.96	0.23
	99.93	100.50	100.43

Eyerman (1911, 3–4) gives an analysis of "white oligoclase," Gillespie's Mill, Kellyville, Delaware County: SiO_2 64.53, Al_2O_3 27.36, Fe_2O_3 1.30, CaO ——, Na_2O 0.20, K_2O 5.80, Ign. 0.69, sum 99.88. It is quite evident that this analysis is erroneous.

LOCALITIES: *Bucks County:* Langhorne, Paxon's quarry, Woodbourne; *Chester County:* Brinton's quarry, Cloud's farm (Kennett), sunstone; Corundum Hill (Newlin), Johnson and Patterson's quarry (Newlin), Fairville (sunstone), Logan's quarry, Mendenhall's quarry, and

Pierce's Paper Mill (Kennett), sunstone; *Delaware County:* Avondale, Black Horse (sunstone), Blue Hill (white, transparent, striated cleavage masses), Elwyn, Gillespie's quarry, Leiperville, Lenni, Mineral Hill (sunstone), Newtown Square, Painter's farm on Dismal Run (yellow, transparent cleavage masses), Sycamore Mills (sunstone), and Ward's quarry; *Montgomery County:* Lafayette, Paper Mills Station, and Willow Grove; *Philadelphia:* Germantown, Fairmount Park, Frankford, Logan, Prince's quarry, Ryers, Tioga, and Wingohocking Creek.

LABRADORITE

$\left\{\begin{matrix}1\ NaAlSi_3O_8\\ 1\text{–}3\ CaAl_2Si_2O_8\end{matrix}\right.$ TRICLINIC

Color: gray, brown, greenish; sometimes with a brilliant play of colors. Luster; *c* pearly to resinous, elsewhere vitreous to subvitreous. Translucent to subtranslucent. Form: massive, cleavable granular. H = 5–6. Sp. gr. 2.70–2.72.

Analyses: A. North side of Devil's Den, Gettysburg, Adams County. Genth, 1876, 221. B. West side of Round Top, near Gettysburg, Adams County. Genth, 1876, 221.

	A	B
SiO_2	54.05	53.85
Al_2O_3	28.81	28.91
FeO	1.36	1.16
MgO	0.26	0.22
CaO	11.05	11.79
K_2O	0.59	0.77
Na_2O	3.36	3.23
Ignition	0.45	0.76
	99.93	100.69

LOCALITIES: *Adams County:* Gettysburg; *Berks County:* Antietam Reservoir? *Chester County:* Copesville, and Pierce's Paper Mill (Kennett); *Delaware County:* Lenni, and Radnor.

ANORTHITE

$CaAl_2Si_2O_8$ TRICLINIC

Color: white, grayish, or reddish. Luster: vitreous. Transparent to translucent. Form: massive, cleavable, granular or lamellar H = 6–6.5. Sp. gr. 2.74–2.76.

Composition: $CaAl_2Si_2O_8$; CaO 20.1, Al_2O_3 36.7, SiO_2, 43.2; Na_2O is usually present.

LOCALITIES: *Chester County:* Corundum Hill (Newlin)? *Delaware County:* Black Horse?

SILICATES: PYROXENE GROUP

ENSTATITE	$MgSiO_3$	Orthorhombic
BRONZITE	$(Mg, Fe)SiO_3$	Orthorhombic
HYPERSTHENE	$(Fe, Mg)SiO_3$	Orthorhombic
DIOPSIDE	$CaMg(SiO_3)_2$	Monoclinic
SALITE	$Ca(Mg, Fe)\ (SiO_3)_2$	Monoclinic
HEDENBERGITE	$CaFe(SiO_3)_2$	Monoclinic
DIALLAGE	$\left\{\begin{matrix}CaMg(SiO_3)_2\\ (Mg, Fe)Al_2SiO_6\end{matrix}\right.$	Monoclinic
AUGITE	$\left\{\begin{matrix}CaMg(SiO_3)_2\\ (Mg,Fe)(Al,Fe)_2SiO_6\end{matrix}\right.$	Monoclinic
WOLLASTONITE	$CaSiO_3$	Monoclinic
PECTOLITE	$HNaCa_2(SiO_3)_3$	Monoclinic

CRYSTALLOGRAPHY OF THE PYROXENE GROUP

ENSTATITE-BRONZITE-HYPERSTHENE

Orthorhombic

$a:b:c = 1.0308:1:0.5885$

$p_0:q_0:r_0 = 0.5709:0.5885:1$

Diopside-Augite Group

Monoclinic

$a:b:c = 1.0934:1:0.5894$; $\beta = 105°51'$

$p_0:q_0:r_0 = 0.5390:0.5670:1$; $\mu = 74°9'$

Common forms: *a* (100), *b* (010), *m* (110), *c* (001), *p* (111), *o* ($\bar{2}21$), Δ ($\bar{3}11$), *d* ($\bar{1}01$). Habit: prismatic. Cleavage: *m* perfect, parting parallel to *c* due to twinning.

Wollastonite

Monoclinic

$a:b:c = 1.0531:1:0.9676$; $\beta = 95°30'$

$p_0:q_0:r_0 = 0.9188:0.9632:1$; $\mu = 84°30'$

Pectolite

Monoclinic

$a:b:c = 1.1140:1:0.9864$; $\beta = 95°20'$

$p_0:q_0:r_0 = 0.8854:0.9821:1$; $\mu = 84°40'$

ENSTATITE

$MgSiO_3$ — Orthorhombic

Color: olive-green, brown. Streak: uncolored or grayish. Translucent to nearly opaque. Luster: vitreous, somewhat pearly on cleavage faces; often metalloidal (bronzite). Form: massive, lamellar or fibrous. H = 5.5. Sp. gr. 3.1–3.3.

Composition: $MgSiO_3$; SiO_2 60, MgO 40, = 100.

Bronzite

$(Mg,Fe)SiO_3$. With increase of Fe it passes into hypersthene. Brown, grayish-green to olive-green; luster of cleavage surface adamantine-pearly to submetallic or bronze-like. Form: cleavage masses; cleavage: *m* easy; parting parallel to *b*.

Analyses: A–B. Enstatite, Rose's quarry, Lower Merion, Montgomery County. H. Trimble, Second Geol. Surv. Penna., C6, 1881, 129. C. Delaware County, "Leiperville." Descloizeaux, 1862, 537, analysis by Pisani (bronzite). D. Castle Rock, Delaware County. Genth, 1875, 63–64, analysis by Pedro G. Salom (bronzite). E. Texas, Lancaster County. Garrett, 1853, 333 (bronzite).

	A	B	C	D	E
SiO_2	53.41	53.32	57.08	55.89	55.45
Al_2O_3	2.12	2.13	0.28		1.13
Fe_2O_3	4.66	4.72	——	12.05	——
FeO	5.71	5.71	5.77		9.60
MnO	0.87	0.38	——	——	0.98
NiO	——	——	——	0.65	——
MgO	32.47	33.72	35.59	29.15	31.83
H_2O	——	——	0.90	1.22	——
	99.24	99.98	99.62	98.96	98.99

Localities: *Bucks County:* Flushing, and Taylor's Woods; *Chester County:* Brinton's quarry (bronzite); *Delaware County:* Black Horse (enstatite and bronzite), Blue Hill (enstatite and bronzite), Concord township, The Hunt (enstatite and bronzite), Mineral Hill, Radnor, Rose Tree, Village Green, and Worrall; *Lancaster County:* Texas, and Wood's chrome mine (bronzite); *Montgomery County:* Rose's quarry; *Philadelphia:* Prince's quarry.

HYPERSTHENE

$(Fe, Mg)SiO_3$ — Orthorhombic

Color: brownish or blackish green or grayish black. Streak: grayish. Luster: somewhat pearly, or metalloidal. Translucent. Form: foliated masses or imbedded grains. H = 5–6. Sp. gr. 3.40–3.50.

Composition: $(Fe, Mg)SiO_3$; Fe : Mg varies from 1 : 3 to 1 : 1, and the FeO content correspondingly from 16.7 to 31.0%; Al_2O_3 is sometimes present.

Localities: *Bucks County:* Feasterville, Finney's quarry, and Langhorne; *Delaware County:* Blue Hill, Castle Rock, The Hunt, and Radnor; *Montgomery County:* Paper Mills Station, and Rose's quarry.

DIOPSIDE

$CaMg(SiO_3)_2$ MONOCLINIC

Color: white, yellowish, grayish-white to pale green, dark green and almost black. Transparent to opaque. Luster: vitreous. Form: prismatic crystals; granular, massive, columnar, lamellar. H = 5–6. Sp. gr. 3.2–3.38.

Varieties: Malacolite,—bluish-gray, grayish-green, whitish, translucent. Mussite,—white, and grayish, lamellar masses. Coccolite,— white to pale green to dark-green; granular. Pyrallolite,— an altered pyroxene.

SALITE. Color: grayish-green to deep green and black. Form: crystals; cleavable masses, and massive granular.

Composition: $Ca(Mg,Fe)(SiO_3)_2$; intermediate between diopside and hedenbergite.

DIALLAGE. Color: grayish-green to bright grass-green, or deep green. Form: lamellar or thin foliated. H = 4. Sp. gr. 3.2–3.35.

Composition: $CaMg(SiO_3)_2$, with some $(Mg, Fe)Al_2SiO_6$; with increase of the latter it passes into augite.

AUGITE

$\left\{ \begin{array}{l} CaMg(SiO_3)_2 \\ (Mg, Fe)(Al, Fe)_2SiO_6 \end{array} \right.$ MONOCLINIC

Color: greenish or brownish-black, pale to dark green. Transparent to opaque. Luster: vitreous, inclining to resinous. Form: imbedded crystals; massive, cleavable. H = 5.5. Sp. gr. 3.2–3.6.

Analyses: A. Diopside ("salite"). Easton, Northampton County. Grayish-green, vitreous to pearly. Eyerman, 1911, 4. B. Diopside ("augite"). Easton, Northampton County, Group of greenish prisms. Eyerman, 1911, 4. C. Diopside. Bailey's quarry, Unionville. Chester County; apple-green, radiating. Eyerman, 1911, 4. D. Malacolite. Bailey's quarry. Unionville, Chester County. Cleavage mass admixed with dolomite. Genth, 1876, 219.

	A	B	C	D
SiO_2	51.05	53.39	52.56	52.19
TiO_2	——	——	1.34	——
Al_2O_3	0.73	0.73	0.86	0.81
Fe_2O_3	——	1.67	——	——
FeO	——	0.97	1.30	0.99
MgO	23.80	17.98	18.00	17.36
CaO	24.59	24.30	25.20	26.07
CO_2	——	——	——	1.79
Ignition	0.14	1.02	1.25	0.73
	100.31	100.06	100.51	99.94
Sp. gr.	3.411			3.229

	E	F	G	H	I	J
SiO_2	47.80	52.23	51.42	49.30	51.64	51.27
TiO_2	0.21	——	——	——	——	——
Al_2O_3	——	3.58	1.94	14.98	4.23	10.01
Fe_2O_3	——	——	——	0.53	——	——
FeO	14.91	2.45	16.41	6.02	16.04	9.11
MnO	——	1.55	0.67	tr.	——	——
CoO	——	——	0.06	——	——	——
CuO	——	——	0.07	——	——	——
MgO	12.65	18.31	9.27	8.27	15.93	13.60
CaO	23.01	20.00	18.97	21.45	10.05	13.23
Na_2O	0.71	——	——	——	0.46	——
K_2O	——	——	——	——	0.16	——
Ignition	0.48	1.79	1.36	——	0.72	1.64
	99.77	99.91	100.17	100.55	99.23	98.86
Sp. gr.	3.331	3.187	3.317			3.008

E. Salite ("diopside"). Vanartsdalen's quarry, Bucks County. Eyerman, 1911, 4. F. Diallage. Railroad cut east of Reading, Berks County. Light green crystals. Smith, 1910, 539. G. Diallage. Gottschall's mine, Berks County. Dark green, slightly submetallic bronze luster. Genth, 1876, 219. H. Augite ("salite"). P. & R. Coal & Iron Co. mine, Alburtis, Lehigh County. Genth, 1875, 65; Sydney Castle, analyst. I. Augite. Gettysburg, Adams County, north side of Devil's Den. Brown vitreous. Genth, 1876, 220. J. Augite. York Haven, York County. Dark green. Ehrenfeld, 1893, 5.

LOCALITIES: Diopside: *Bucks County:* Vanartsdalen's quarry (coccolite); *Chester County:* Bailey's quarry (malacolite, mussite, and coccolite), Burnett's quarry (mussite), Steele's mine (coccolite); *Lebanon County:* Cornwall (mussite); *Northampton County:* Chestnut Hill, and Redington (coccolite).

Salite: *Berks County:* Siessholtzville; *Bucks County:* Vanartsdalen's quarry; *Chester County:* Burnett's quarry, French Creek mines; *Northampton County:* Chestnut Hill.

Diallage: *Berks County:* Gottschall's mine (Alsace); *Chester County:* Corundum Hill (Newlin), and French Creek mines.

Augite: *Berks County:* Antietam Reservoir, and Stony Creek Mills; *Bucks County:* Vanartsdalen's quarry; *Chester County:* Burnett's quarry, Coventryville, French Creek Mines, Jackson's quarry (New Garden), and London Grove; *Lancaster County:* Gap nickel mines? *Northampton County:* Chestnut Hill.

WOLLASTONITE

$CaSiO_3$ MONOCLINIC

Color: white, gray, yellow. Subtransparent to translucent. Luster: vitreous, on cleavage surfaces pearly. Form: cleavable masses; rarely in tabular or short prismatic crystals; fibrous. H = 4.5–5. Brittle. Sp. gr. 2.8–2.9.

Composition: $CaSiO_3$; SiO_2 51.7, CaO 48.3, = 100.

Analysis: Vanartsdalen's quarry, Bucks County. Morton, 1829, 48.

SiO_2.....	51.50
CaO.....	44.10
FeO.....	1.00
Ignition.....	0.75
	97.35

LOCALITY: *Bucks County:* Vanartsdalen's quarry.

PECTOLITE

$HNaCa_2(SiO_3)_3$ MONOCLINIC

Color: white or grayish. Luster: silky or subvitreous. Subtransparent to opaque. Form: compact aggregates of acicular crystals; fibrous masses, radiated to stellate. Distinct crystals are rare. Cleavage: *a* (100), and *c* (001) perfect. H = 5. Brittle. Sp. gr. 2.68–2.78.

Composition: $HNaCa_2(SiO_3)_3$; SiO_2 54.2, CaO 33.8, Na_2O 9.3, H_2O 2.7, = 100.

Analyses: A. Hosensack Station, Lehigh County. Compact masses of acicular crystals, grayish; with stilbite. Smith and Knerr, Am. Chem. J., VI, 411, 1885. B. Rock Hill, Lancaster County. Beck, 1912, 8.

	A	B
SiO_2.....	55.17	51.88
Al_2O_3.....	——	1.42
Fe_2O_3.....	0.80	——
CaO.....	30.00	31.50
K_2O.....	0.37	0.29
Na_2O.....	9.02	10.79
H_2O.....	4.63	3.27
	99.99	99.15
Sp. gr.....	2.6	

LOCALITIES: *Delaware County:* Henvi's quarry; *Lancaster County:* Rockhill; *Lehigh County:* Hosensack Station; *Philadelphia:* Frankford, and Rittenhouse quarry.

SILICATES, AMPHIBOLE GROUP

ANTHOPHYLLITE	$(Mg, Fe)SiO_3$	Orthorhombic
TREMOLITE	$CaMg_3(SiO_3)_4$	Monoclinic
ACTINOLITE	$Ca(Mg, Fe)_3(SiO_3)_4$	Monoclinic
CUMMINGTONITE	$(Fe, Mg)SiO_3$	Monoclinic
HORNBLENDE	$Ca(Mg, Fe)_3Si_4O_{12}$ $Na_2Al_2Si_4O_{12}$ $(Mg, Fe)_3(Al, Fe)_4Si_2O_{12}$	Monoclinic
CROCIDOLITE	$NaFe(SiO_3)_2$ $FeSiO_3$	Monoclinic

CRYSTALLOGRAPHY OF AMPHIBOLE GROUP

Monoclinic amphiboles: $a:b:c = 0.5482:1:0.2937$; $\beta = 104° 58'$.

$p_0:q_0:r_0 = 0.5357:0.2837:1$; $\mu = 75° 2'$.

Common forms: *a* (100), *b* (010), *c* (001), *m* (110), *e* (130), *r* (011). Habit: prismatic. Cleavage: *m* highly perfect, *a* and *b* sometimes distinct. Parting, due to twinning, parallel to *a* and *c* sometimes observed.

ANTHOPHYLLITE

$(Mg, Fe)SiO_3$ ORTHORHOMBIC

Color: brownish-gray, yellowish, brown, or brownish-green, sometimes metalloidal. Transparent to subtranslucent. Luster: vitreous, sometimes pearly on cleavage faces. Form: lamellar or fibrous masses, often radiated. Cleavage: prismatic, perfect; *b* less so, *a* sometimes distinct. H = 5.5–6. Sp. gr. 3.1–3.2.

Composition: $(Mg, Fe)SiO_3$; For Mg:Fe = 3:1, SiO_2 55.6, FeO 16.6, MgO 27.8, = 100. The mineral is frequently altered more or less to talc; most analyses therefore show some water. Examination of thin sections of radiating anthophyllite show quite an admixture of talc, chlorite, and other minerals.

Analyses: A. Concord, "Star Rock," Delaware County. "Antholite." Leeds, 1873, 24. B. Castle Rock, Delaware County. Grayish-white, fibrous, with talc. Genth, 1882, 395. C. Lafayette, Montgomery County. "Tremolite." Yellowish, greenish, and reddish, bladed and fibrous masses. Leeds, 1875, 230. D. Oakford, Bucks County. "Hydrous anthophyllite." The mineral appears to be a weathered anthophyllite with much adsorbed water. The analysis, however, may be erroneous. Eyerman, 1911, 5.

	A	B	C	D
SiO_2.....	55.12	56.88	59.25	54.46
Al_2O_3.....	0.55	2.45	2.45	1.14
Cr_2O_3.....	——	tr.	——	——
FeO.....	8.20	9.20	6.49	4.65
MnO.....	0.33	0.28	1.05	——
NiO.....	——	0.17	——	——
CaO.....	0.75	——	1.57	0.67
MgO.....	31.18	28.50	28.16	16.00
Na_2O.....	1.55	0.18	——	——
K_2O.....	1.01	0.03	——	——
H_2O (Ign.)..	2.21	2.28	——	22.73
	100.90	99.97	98.97	99.65
Sp. gr.....	3.20	2.983		

LOCALITIES: *Bucks County:* Flushing, and Taylor's Woods; *Chester County:* Brandywine feldspar quarry (West Nottingham), and Osborn Hill? *Delaware County:* Blue Hill, Castle Rock, Hannum's farm (Concord), The Hunt, Mineral Hill, Moro Phillip's chrome mine, Peter's Mill dam (Aston); *Lancaster County:* Texas; *Philadelphia:* Bustleton, Prince's quarry, and Wissahickon Valley.

TREMOLITE

$CaMg_3(SiO_3)_4$ MONOCLINIC

Color: white to dark gray. Transparent to translucent. Form: columnar or fibrous masses; short and stout prismatic crystals. H = 5–6. Brittle. Sp. gr. 2.9–3.1.

Composition: $CaMg_3(SiO_3)_4$; SiO_2 57.7, MgO 28.9, CaO 13.4, = 100. Fe may replace Mg up to 3%, with increase of Fe the mineral passes into actinolite.

Analyses: A. Tremolite. Old Wolf quarry, Easton, Northampton County. White, somewhat fibrous crystals; non-pleochroic, extinction angles up to 20°. Merrill, 1890, 600; analysis by Eakins. B. Tremolite. Pusey's quarry, Kennett Square, Chester County. Silky-white, semi-fibrous. Eyerman, 1911, 5.

	A	B
SiO_2	58.27	57.16
Al_2O_3	0.33	——
Fe_2O_3	tr.	——
FeO	——	0.42
MnO	0.08	——
CaO	11.90	14.00
MgO	25.93	26.08
K_2O	0.42	——
Na_2O	1.25	——
Ignition	1.22	2.50
	99.40	100.16
Sp. gr.		2.998

LOCALITIES: *Bucks County:* Vanartsdalen's quarry; *Chester County:* Avondale, Bailey's quarry, Brown's quarry, Cope's quarry, Doe Run quarries, Kennett Square, Logan's quarry, Mendenhall's quarry, Nevin's quarry, Poorhouse quarry, Pusey's quarries; Sylmar, and Wilson's quarry; *Delaware County:* Blue Hill, Castle Rock, Concord township, Lenni, Mineral Hill, Newtown Square, and Painter's farm on Dismal Run; *Montgomery County:* Rose's quarry; *Northampton County:* Chestnut Hill; *Philadelphia:* Wissahickon Valley.

ACTINOLITE

$Ca(Mg, Fe)_3(SiO_3)_4$ MONOCLINIC

Color: grayish-green to bright green; grayish when altered. Form: columnar or fibrous; massive; long or short bladed crystals, breaking across the prism. Luster: vitreous. Transparent to subtranslucent. H = 5–6. Sp. gr. 3–3.2.

Varieties, Nephrite— tough, compact, fine-grained, with a splintery fracture. H = 6–6.5. Sp. gr. 2.96–3.1. Amphibole asbestus— yellowish, whitish, or grayish, long flexible fibers. Luster: silky. Mountain-leather and mountain cork: in thin flexible sheets of interlaced fibers. White, gray, or yellowish. Mountain wood: gray to brown, compact, fibrous.

Analyses of Actinolite: A. Easton, Northampton County. "Nephrite," green, bladed. Eyerman, 1911, 5. B. Reservoir quarry, Easton, Northampton County. Grayish-green. Eyerman, 1904, 47. C. Concord, Delaware County. Green, glassy. Seybert, 1821, 331. D. Mineral Hill, Delaware County. Green, bladed, Eyerman, 1911, 5.

	A	B	C	D
SiO_2	60.26	54.35	56.23	56.34
Al_2O_3	2.57	——	1.67	1.49
Cr_2O_3	——	——	tr.	——
FeO	1.85	2.27	4.30	5.32
CaO	13.40	13.43	10.67	11.63
MgO	20.05	28.05	24.00	21.99
Ignition	2.29	1.25	1.03	3.32
	100.42	99.35	97.90	100.09
Sp.gr.	3.010		2.987	

Analyses of Asbestus: A. Asbestus, Aston, Delaware County. Analyst, Earl V. Shannon. The writer is indebted to Dr. George P. Merrill for this unpublished analysis. B. Asbestus, Delaware River quarry, Easton, Northampton County. Eyerman, 1904, 47.

	A	B
SiO_2.....	53.11	55.25
Al_2O_3.....	tr.	——
FeO.....	3.11[45]	2.18
CaO.....	14.00	12.66
MgO.....	23.39[46]	30.19
Ignition.....	6.85	——
	100.46	100.28

LOCALITIES: Actinolite: *Berks County:* Antietam Reservoir, and Jones mine; *Bucks County:* Flushing, and Vanartsdalen's quarry; *Chester County:* Brinton's quarry, Cope's quarry, Corundum Hill (Newlin), Gregg's farm (Kennett), French Creek mines, Osborn Hill, Warwick mines, and Willistown; *Delaware County:* Black Horse, Blue Hill, Bonsall's farm (Middletown), Concord township, Lenni, Marple township, Mineral Hill, Peter's Mill dam (Aston), Rockdale, Williamson School; *Lancaster County:* Gap mines, and Pleasant Grove; *Montgomery County:* Gladwyne, and opposite Lafayette; *Northampton County:* Chestnut Hill (nephrite?). *Philadelphia:* Bustleton, Fairmount Park, Germantown, Prince's quarry, Wissahickon Valley.

Asbestus: *Berks County:* Antietam Reservoir, Boyertown (mountain-leather), and Earlville; *Bucks County:* Flushing; *Chester County:* Avondale (mountain-leather), Sylmar, Brinton's quarry, Corundum Hill (Newlin), Dunlap's quarry, Edward's quarry, Moro Phillips' chrome mine, Mt. Rocky Meeting House (East Nottingham), Taylor's quarry, and Willistown; *Delaware County:* Blue Hill, Castle Rock, Concord township, Darby, The Hunt, Lenni, Mineral Hill, Radnor (asbestus and mountain-cork), Rockdale (formerly mined), Rose Tree (Smedley's asbestus pit), Village Green, and Worrall; *Lancaster County:* Gap mine, and White Rock; *Lebanon County:* Cornwall; *Lehigh County:* Friedensville (mountain-leather); *Montgomery County:* opposite Lafayette, Rose's quarry; *Northampton County:* Chestnut Hill (fibrous masses 65 cm. in length); *Philadelphia:* Fairmount Park, Prince's quarry, and Wissahickon Valley; *York County:* Emigsville, and York Valley.

HORNBLENDE

$Ca(Mg, Fe)_3(SiO_3)_4$
$Na_2Al_2(SiO_3)_4$
$(Mg, Fe)_3(Al, Fe)_4Si_3O_{12}$

MONOCLINIC

Color: bright to dark green; black. Translucent to opaque. Luster: vitreous. Form: columnar, fibrous, short stout prismatic crystals. H = 5–6. Sp. gr. 3.05–3.47.

Byssolite: green, fibrous and acicular; often in matted masses, or enclosed within calcite coloring the latter a deep green.

Analysis: Birmingham Township, Delaware County. Dark green. Sharples, 1866, 271.

SiO_2.....	47.77
Al_2O_3.....	7.69
FeO.....	15.41
MnO.....	0.26
CaO.....	13.16
MgO.....	15.28
	99.57

Byssolite. French Creek mines, Chester County. Goldsmith (1893, 175) published an analysis of "asbeferrite:" Sp. gr. 2.6, SiO_2 48.45, Fe_2O_3 33.90, CaO 11.80, MgO 6.23, sum 100.38. This analysis is undoubtedly erroneous.

LOCALITIES: *Berks County:* Antietam Reservoir, and Mohrville; *Bucks County:* Morris-

[45] State of oxidation of Fe not determined.
[46] Organic matter in part.

ville, and Rockhill; *Chester County:* Burnett's quarry, Copesville, French Creek mines, Hopewell mines, Pierce's Paper Mill (Kennett), Osborn Hill, Warwick mines, and Webb's Mill; *Delaware County:* Bain's quarry, Black Horse, Concordville, Franklin Paper Mill, Gillespie's quarry, Lenni, Mineral Hill, Morgan Station, Rockdale, Ward's quarry, and Williamson School; *Lancaster County:* Adamstown, and Gap mines; *Montgomery County:* Congo, opposite Lafayette, Ogontz, and Paper Mills Station; *Northampton County:* Chestnut Hill; *Philadelphia:* Branchtown, Bustleton, Fairmount Park, Frankford, Germantown, Logan, O'Neill's quarry, Overbrook, Prince's quarry, Rittenhouse quarry, Tioga, West Philadelphia, Wingohocking Creek, and Wissahickon Valley.

Byssolite: *Berks County:* Boyertown, Longswamp township, and Jones mine; *Chester County:* French-Creek mines (bright green acicular crystals and matted masses, or enclosed within calcite), Hopewell mines, and Warwick mines; *Lebanon County:* Cornwall.

CROCIDOLITE

$\left\{\begin{matrix}NaFe(SiO_3)_2\\FeSiO_3\end{matrix}\right.$ MONOCLINIC

Color: lavender-blue to leek-green. Opaque. Luster: silky. Form: fibrous, asbestus-like, or massive. H = 4. Sp. gr. 3.20–3.30.

Composition: $NaFe(SiO_3)_2.FeSiO_3$; SiO_2 49.6, Fe_2O_3 22.0, FeO 19.8, Na_2O 8.6, = 100.

Analyses: A–B.; $^3/_4$ of a mile east of Shanesville, Berks County. Bliss, 1913, 525; analyses by Edwin De Barr. C. Hill Church, Berks County. McCreath, Second Geol. Surv. Penna. Rep., D3, II, 1883, 94.

	A	B	C
SiO_2.....	83.30	58.50	51.70
Al_2O_3.....	6.00	12.38	17.54
Fe_2O_3.....	5.10	14.32	——
FeO.....	2.90	4.79	9.22
MnO.....	——	3.16	——
CaO.....	tr.	0.92	5.06
MgO.....	1.20	4.30	8.76
Na_2O.....	0.30	4.09	——
K_2O.....	0.15	0.48	——
	98.95	102.94	92.28

LOCALITIES: *Berks County:* Barto, Eshbach, Gabelsville, Gilbert's Ore Pit, Hill Church, Little Oley, Shanesville, and near Weist School (Alsace); *Lehigh County:* Limeport. *Philadelphia:* Fairmount Park, and Frankford.

SILICATES, BERYL GROUP

BERYL $Be_3Al_2(SiO_3)_6$ HEXAGONAL

BERYL

$Be_3Al_2(SiO_3)_6$ HEXAGONAL

Colorless, white, yellow, pale green, light blue; emerald-green. Transparent to subtranslucent. Luster: vitreous. Form: hexagonal prisms; coarse columnar masses. H = 7.5–8. Brittle. Sp. gr. 2.63–2.80.

Crystallography: Hexagonal; c = 0.8643; p_0 = 0.5762. Common forms: *c* (0001), *m* $(10\bar{1}0)$, *a* $(11\bar{2}0)$, *p* $(10\bar{1}1)$, and *s* $(11\bar{2}1)$. Habit: prismatic, rarely tabular. Cleavage: basal, imperfect; parting, prismatic.

Composition: $Be_3Al_2(SiO_3)_6$; SiO_2 67.0, Al_2O_3 19.0, BeO 14.0, = 100. Be may be replaced by Na, Li, or Cs.

Analyses: A. Chester, Delaware County. Yellowish-green. Eyerman, 1911, 5. B. Broad Street and Olney Avenue, Philadelphia. Yellowish-green, Eyerman, 1911, 5. C. Smedley's farm, Middletown, Delaware County. Dark greenish-blue. Eyerman, 1911, 5.

	A	B	C
SiO_2	66.00	66.71	65.79
Al_2O_3	17.60	16.10	15.53
Fe_2O_3	4.98	.1.87	1.64
BeO	10.53	12.90	13.85
Ignition	0.95	2.08	3.07
	100.06	99.66	99.88
Sp. gr.	2.650	2.691	2.680

LOCALITIES: *Chester County:* Avondale, Beryl Hill (opaque green crystals up to 51 pounds in weight), Brandywine Battle Field, Sylmar, Brinton's quarry, Corundum Hill (Newlin), Embreeville, Pugh's farm (East Nottingham), Toughkenamon, Webb's Mill; *Delaware County:* Adele, Avondale (colorless, white, yellow, and green), Boothwyn (green crystals, 7.5 × 30 cm.), Bunting's quarry, Burk's quarry, Castle Rock, Concord township, Custer's farm (Darby), Green's farm near Upland, Franklin Paper Mill, Leiperville (blue, green, and yellow, translucent to transparent crystals up to 5 × 30 cm.), Lewis's farm, Llanerch, Mineral Hill (dark greenish-blue), Morton, Peter's Mill dam (Aston), Sharpless' quarry near Glen Mills, Shaw and Esrey's quarry in Chester, Strath Haven Inn, Trainer (pale green opaque crystals, 6.5 × 30 cm.), Upper Darby, Worrall, Worrall's farm (Marple and Upper Providence), Yarnall's farm (Edgemont); *Montgomery County:* Flat Rock tunnel; *Philadelphia:* Chestnut Hill, Cobb's Creek, Fairmount Park, Germantown, Logan (white, yellow, green), Overbrook, Ryers, and Shawmont.

SILICATES, GARNET GROUP

GROSSULARITE	$Ca_3Al_2(SiO_4)_3$	Isometric
PYROPE	$Mg_3Al_2(SiO_4)_3$	Isometric
ALMANDITE	$Fe_3Al_2(SiO_4)_3$	Isometric
SPESSARTITE	$Mn_3Al_2(SiO_4)_3$	Isometric
ANDRADITE	$Ca_3Fe_2(SiO_4)_3$	Isometric
UVAROVITE	$Ca_3Cr_2(SiO_4)_3$	Isometric

Crystallography: Isometric. Common forms: *d* (110), *n* (211), and *s* (321).

GROSSULARITE

$Ca_3Al_2(SiO_4)_3$ ISOMETRIC

Color: white, pale-green, amber, honey-yellow, cinnamon-brown, pale rose-red. Streak: white. Luster: vitreous to resinous. Transparent to subtranslucent. Form: dodecahedral crystals. H = 6.5–7.5. Sp. gr. 3.55–3.66.

Composition: SiO_2 40.0, Al_2O_3 22.7, CaO 37.3, = 100. Fe^{II} may replace Ca, and Fe^{III} may replace Al.

Analyses: Deshong's quarry, Leiperville, Delaware County. A. Yellow. Koenig, 1878, 82. R. B. Chipman, analyst. B. Greenish. Koenig, 1878, 82. R. B. Chipman, analist. C. Light yellowish-brown. Eyerman, 1911, 6.

	A	B	C
SiO_2	39.80	39.08	38.74
Al_2O_3	21.16	23.26	18.70
Fe_2O_3	3.14	0.80	2.99
FeO	0.72	0.86	——
MnO	1.80	7.60	1.05
CaO	34.00	28.50	37.77
MgO	tr.	——	——
Na_2O	——	——	0.19
Ignition	none	0.32	0.59
	100.62	100.42	100.03
Sp. gr.	3.637	3.238	3.638

LOCALITIES: *Berks County:* Fritz Island; *Dauphin County:* Hummelstown; *Delaware County*: Leiperville (yellow and green, dodecahedral crystals); *Lehigh County:* Limeport; *Philadelphia:* Cobb's Creek valley.

ALMANDITE

$Fe_3Al_2(SiO_4)_3$ ISOMETRIC

Color: deep red, brownish-red, black. Transparent to subtranslucent. Luster: vitreous to resinous. Form: dodecahedral or trapezohedral crystals. H = 6.5–7.5. Sp. gr. 3.9–4.2.

Composition: SiO_2 36.2, Al_2O_3 20.5, FeO 43.3, = 100. Fe^{III} may replace Al, and Mg may replace Fe^{II}.

Analyses: A. Peter's Mill dam, Green's Creek, Delaware County. "Pyrope." Deep blood-red. Genth, 1855, 20; Chas. A. Kurlbaum, analyst. B. Chelsea, Delaware County. Genth, Jr., 1880, 311. C. Darby, Delaware County. Genth, Second Geol. Surv. Penna. Rep., C5, 1885, 114. Titaniferous almandite. D. Titaniferous almandite. Darby, Delaware County. Keller, 1882, 54.

	A	B	C	D
SiO_2.....	40.15	41.11	35.97	36.92
TiO_2.....	——	——	5.12	1.14
Al_2O_3.....	20.77	21.60	18.72	26.54
Fe_2O_3.....	——	2.11	1.39	3.74
FeO.....	26.66	25.86	30.42	27.36
MnO.....	1.85	2.22	0.42	0.33
MgO.....	8.08	5.41	5.08	1.66
CaO.....	1.83	1.89	2.79	2.76
	99.34	100.20	99.91	100.45
Sp. gr.....		4.028	4.186	4.25

E. Sycamore Mill, Delaware County. Eyerman, 1904, 48. F. Lafayette, Montgomery County. Eyerman, 1911, 6. G. Rocksville, Bucks County. Altered, brown. Eyerman, 1911, 6. H. Mohr's mine, near Shimersville, Lehigh County. Dark red, imperfect crystals. Smith, 1883, 276.

	E	F	G	H
SiO_2.....	36.22	37.03	41.69	35.92
Al_2O_3.....	24.58	19.53	20.19	19.18
Fe_2O_3.....	——	——	22.69	4.92
FeO.....	30.71	28.71	13.01	29.47
MnO.....	8.97	1.51	——	4.80
CaO.....	——	5.94	1.99	2.38
MgO.....	——	6.90	——	3.70
Ignition....	——	0.41	1.09	——
	100.48	100.03	100.66	100.37
Sp. gr.....	3.991	4.091	3.881	4.03

LOCALITIES: *Bucks County:* Eden, Finney's quarry, Hulmeville, Mt. Misery, Newportville, and Trevose; *Chester County:* Avondale (crystals measuring 16 cm.), Corundum Hill (Newlin), Craig's farm (Pennsbury), Dilworth's farm (Pennsbury), Goshenville, Johnson and Patterson's quarry (Newlin), Lewisville, near Logan's quarry; Lower Oxford township; Marshallton, Minorcus Hill, one mile south of Nottingham, near Taylor's quarry, south of Phillip's quarries, Toughkenamon, Unionville; *Delaware County:* Adele, Avondale, Boothwyn (red dodecahedra and trapezohedra, 1 to 6 cm.), Brandywine Summit, Brookthorpe, Burmont, Castle Rock, Chelsea, Cream Valley, Crozer's quarry in Chester, Darby (jet black, titaniferous), Dickinson's Mill, Drexel's quarry, Folsom (crystals up to 7.5 cm.), Franklin Paper Mill, Gillespie's quarry, Glen Riddle, Grassland, Irving's quarry in Chester, Kellyville, Leiperville, Llewellyn Mills, Lenni, Mineral Hill, Morton, Radnor, Ridleyville, Sharpless' quarry near Glen Mills, Shaw and Esrey's quarry in Chester, Smedley's quarry near Lima, Strath Haven Inn, Swarthmore, St. Davids, Sycamore Mills, Trainer, Ward's quarry, and Worrall's farm (Marple and Upper Providence); *Lehigh County:* Shimersville; *Montgomery County:* Barren Hill (a crystal measuring 15 cm. was found in digging a well), Flat Rock tunnel, Gladwyne, Ogontz, Paper Mills Station, and Wyncote; *Philadelphia:* Branchtown, Bustleton, Chestnut Hill, Fairmount Park,

Frankford, Germantown, Holmesburg, Logan, Manayunk, Nicetown, Overbrook, Prince's quarry, Rittenhouse quarry, Ryers, Shawmont, Tacony Creek, Vereeville, West Philadelphia, and Wissahickon Valley.

SPESSARTITE

$Mn_3Al_2(SiO_4)_3$ ISOMETRIC

Color: dark hyacinth red, sometimes with a tinge of violet; brownish-red. Transparent to subtranslucent; opaque. Luster: vitreous or resinous. Form: dodecahedral or trapezohedral crystals, massive. H = 6.5–7.5. Sp. gr. 4.0–4.3.

Composition: SiO_2 36.4, Al_2O_3 20.6, MnO 43.0, = 100. Fe^{II} replaces Mn, and Fe^{III} replaces Al.

Analyses: A. Fairmount Park, Philadelphia. B. Avondale, Delaware County. Robinson, 1887, 251. Each an average of 2 analyses.

	A	B
SiO_2	38.24	40.92
Al_2O_3	19.62	9.24
Fe_2O_3	2.27	1.13
FeO	13.60	9.28
MnO	25.30	38.34
CaO	0.53	tr.
	99.56	98.91
Sp. gr.	4.23	4.12

LOCALITIES: *Berks County:* Bernharts; *Chester County:* Osborn Hill; *Delaware County:* Avondale (brilliant red crystals up to 6 cm.), Boothwyn, Burk's quarry, and Concord township; *Philadelphia:* Fairmount Park, Holmesburg, Germantown, and Roxborough.

ANDRADITE

$Ca_3Fe_2(SiO_4)_3$ ISOMETRIC

Color: yellow, green, brownish-red, brownish-yellow, brown, black. Transparent to opaque. Luster: vitreous or resinous. Form: dodecahedral or trapezohedral crystals; massive, compact. H = 6.5–7.5. Sp. gr. 3.8–3.9.

Composition: SiO_2 35.5, Fe_2O_3 31.5, CaO 33.0, = 100 Al replaces Fe^{III}; Fe^{II}, Mn, or Mg may replace the Ca.

Melanite: black, dull or lustrous.

Analyses: A. French Creek mines, Chester County. Brownish-gray to ash-gray. Genth, 1890, 117. B. French Creek mines, Chester County. Dark brown crystals. Eyerman, 1904, 48. C. Weber's farm, Lower Saucon, Northampton County. Dark brown. Eyerman, 1911, 6. D. Near Hosensack Station, Lehigh County. Yellow. Smith, Am. Chem. J., V., 277, 1883. The specific gravity determinations are probably erroneous.

	A	B	C	D
SiO_2	41.42	35.42	35.46	35.25
Al_2O_3	18.09	8.51	7.50	——
Fe_2O_3	10.81	21.04	26.04	32.17
FeO	——	——	——	0.92
MnO	0.88	9.88	1.14	——
CaO	26.19	25.67	29.60	30.80
MgO	0.59	——	——	tr.
CO_2	1.71	——	——	——
Ignition	0.51	——	——	——
	100.20	100.52	99.74	99.14
Sp. gr.	3.390	3.719	3.790	5.05–5.27

LOCALITIES: *Berks County:* Bernharts; *Bucks County:* New Hope; *Chester County:* French Creek mines (crystals measuring 6 cm.), Hopewell mines, Steele's mine, and Warwick mines; *Lebanon County:* Cornwall (brownish-red and brown-olive crystals measuring 2.5 cm.); *Lehigh County:* Hosensack Station; *Northampton County:* Redington; *Warren County:* Warren? (melanite); *York County:* Dillsburg.

UVAROVITE

$Ca_3Cr_2(SiO_4)_3$ — Isometric

Color: emerald green. Transparent to subtranslucent. Luster: vitreous. Form: dodecahedral crystals, usually small. H = 6.5–7.5. Sp. gr. 3.41–3.52.

Composition: SiO_2 35.9, Cr_2O_3 30.6, CaO 33.5, = 100. Al may replace part of the Cr.

Locality: *Lancaster County:* Wood's chrome mine.

OTHER ORTHOSILICATES

Olivine	$(Mg, Fe)_2SiO_4$	Orthorhombic
Fayalite	Fe_2SiO_4	Orthorhombic
Dioptase	$H_2Cu_2SiO_4$	Rhombohedral
Wernerite	$\begin{cases} m\ Ca_4Al_6Si_6O_{25} \\ n\ (Na_4Al_3Si_9O_{31}Cl \end{cases}$	Tetragonal
Vesuvianite	$Ca_6Al_3(OH,F)(SiO_4)_5$	Tetragonal
Zircon	$ZrSiO_4$	Tetragonal
Topaz	$Al_2F_2SiO_4$	Orthorhombic
Andalusite	Al_2SiO_5	Orthorhombic
Sillimanite	Al_2SiO_5	Orthorhombic
Cyanite	Al_2SiO_5	Triclinic
Datolite	$Ca(B,OH)SiO_4$	Monoclinic
Gadolinite	$Be_2Fe(YO)_2(SiO_4)_2$	Monoclinic
Zoisite	$Ca_2(AlOH)Al_2(SiO_4)_3$	Orthorhombic
Epidote	$\begin{cases} m\ Ca_2(AlOH)Al_2(SiO_4)_3 \\ n\ Ca_2(FeOH)Al_2(SiO_4)_3 \end{cases}$	Monoclinic
Piedmontite	$Ca_2(AlOH)(Al,Fe,Mn)_2(SiO_4)_3$	Monoclinic
Allanite	$(Ca,Fe)_2(AlOH)(Al,Ce,Fe)_2(SiO_4)_3$	Monoclinic
Axinite	$HCa_2(Fe,Mn)Al_2B(SiO_4)_4$	Triclinic
Prehnite	$H_2Ca_2Al_2(SiO_4)_3$	Orthorhombic
Chondrodite	$Mg_3[Mg(F,OH)]_2[SiO_4]_2$	Monoclinic
Ilvaite	$CaFe_2(FeOH)(SiO_4)_2$	Orthorhombic

ORTHOSILICATES OR METASILICATES

Calamine	$H_2Zn_2SiO_5$	Orthorhombic
Tourmaline	$R^I_3Al_3(B,OH)_2Si_4O_{18}$	Rhombohedral
Staurolite	$FeAl_5(OH)(SiO_6)_2$	Orthorhombic

OLIVINE

$(Mg,Fe)_2SiO_4$ — Orthorhombic

Color: olive-green, sometimes brownish. Luster: vitreous. Transparent to translucent. Form: imbedded grains. H = 6.5–7. Brittle. Sp. gr. 3.27–3.37.

Analysis: Castle Rock, Delaware County. Grains in peridotite. Genth, 1875, 63–64. Pedro G. Salom, analyst.

SiO_2	45.15
FeO	19.38
MgO	31.49
CaO	3.88
Al_2O_3	tr.
	99.90

Localities: *Delaware County:* Castle Rock, and Williamson School; *Lancaster County:* Wood's chrome mine; *Philadelphia:* Prince's quarry?

FAYALITE

Fe_2SiO_4 ORTHORHOMBIC

Color: light yellow, transparent; becomes dark brown to black and opaque on exposure. Luster: resinous, or metalloidal. Form: imbedded grains or minute crystals. H = 6.5. Sp. gr. 4.

Composition: Fe_2SiO_4; FeO 79.6, SiO_2 29.4, = 100.

LOCALITY: *Berks County:* Boyertown?

DIOPTASE

$H_2Cu_2SiO_4$ RHOMBOHEDRAL (Tetartohedral)

Color: emerald-green. Streak: green. Luster: vitreous. Transparent to subtranslucent. Form: rhombohedral crystals, in indistinct crystalline aggregates. Cleavage, rhombohedral, perfect. H = 5. Sp. gr. 3.

Composition: $H_2Cu_2SiO_4$; CuO 50.4, SiO_2 38.2, H_2O 11.4, = 100.

LOCALITY: *Montgomery County:* Perkiomen mine?

WERNERITE

$\begin{cases} m\ Ca_4Al_6Si_6O_{25} \\ n\ Na_4Al_3Si_9O_{24}Cl \end{cases}$ TETRAGONAL

Color: white, gray, bluish, greenish. Streak: uncolored. Transparent to subtranslucent. Luster: vitreous to pearly, inclining to resinous. Form: prismatic crystals; massive, granular, columnar. H = 5–6. Brittle. Sp. gr. 2.66–2.73.

Crystallography: Tetragonal; c, p_0 = 0.440. Common forms: *c* (001), *a* (100), *m* (110), and *r* (111). Habit: prismatic; crystals usually coarse and rough. Cleavage: *a* and *m* distinct but interrupted.

Analyses: A. French Creek mines, Chester County. On 400 foot level of the Elizabeth mine. White to grayish, striated prismatic crystals, with andradite, magnetite and pyrite. Genth, 1890, 117. B. Mineral Spring quarry, Easton, Northampton County. Eyerman, 1911, 7. C. Vanartsdalen's quarry, Bucks County. Grayish-blue, with graphite. Eyerman, 1911, 7. D. Vanartsdalen's quarry, Bucks County. Greenish-white, translucent, compact. Leeds, 1870, 62; 1873, 26.

	A	B	C	D
SiO_2	52.30	54.61	49.01	47.47
Al_2O_3	23.68	24.79	26.77	27.51
Fe_2O_3	0.58	0.32	——	tr.
FeO	——	——	0.39	——
CaO	12.36	2.06	16.89	17.59
MgO	0.05	9.01	——	1.20
Na_2O	6.29	4.41	3.30	3.05
K_2O	0.77	1.25	1.80	1.40
CO_2	2.63	——	——	——
Cl	——	2.00	——	——
H_2O	1.50	1.76	1.70	1.48
	100.16	100.21	99.86	99.70
Sp. gr.	2.675	2.610	2.689	2.708

LOCALITIES: *Berks County:* Fritz Island; *Bucks County:* Vanartsdalen's quarry; *Chester County:* Bailey's quarry, Copesville, Doe Run quarries, French Creek mines, Kennett Square, Nevin's quarry, and Willowdale; *Northampton County:* Chestnut Hill (pink, prismatic crystals); *Philadelphia:* Frankford, O'Neill's quarry.

VESUVIANITE

$Ca_6Al_3(OH,F)(SiO_4)_5$ TETRAGONAL

Color: brown, green. Subtransparent to subtranslucent. Luster: vitreous, inclining

to resinous. Form: prismatic crystals, massive, columnar, granular. H = 6.5. Brittle. Sp. gr. 3.35–3.45.

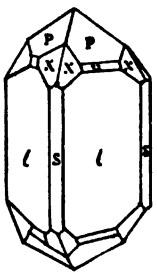
Crystallography: Tetragonal; c, p_0 = 0.5372. Common forms: *c* (001), *m* (110), *p* (111), *a* (100). Cleavage: *m* indistinct. Fracture: subconchoidal, uneven.

LOCALITIES: *Berks County:* Fritz Island; *Bucks County:* New Hope; *Chester County:* Doe Run quarries, and Willowdale; *Lancaster County:* Wood's chrome mine? *Lebanon County:* Cornwall.

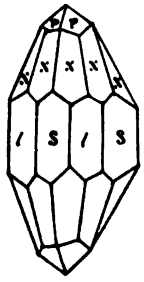
ZIRCON

$ZrSiO_4$ TETRAGONAL

Color: red, reddish-brown. Streak: uncolored. Translucent, subtranslucent, opaque. Luster: adamantine. Form: square prismatic crystals with pyramidal terminations. H = 7.5. Brittle. Sp. gr. 4.68–4.70.



57



58

Figs. 57–58. Zircon, Old York Road, Philadelphia (*Troost*).

Crystallography: Tetragonal; c, p_0 = 0.6403. Common forms: *a* (100), *m* (110), *p* (111), *u* (331), *x* (131). Habit: prismatic; rarely pyramidal. Cleavage: *m*, *p*, imperfect. Fracture: conchoidal.

Composition: $ZrSiO_4$; SiO_2 32.8, ZrO_2 67.2, = 100. A small amount of Fe_2O_3 is usually present.

Cyrtolite: (Altered zircon). Color: yellow, red, yellowish-brown, or brownish-red. Luster: somewhat adamantine. Form: a combination of *m* (11) and *e* (101) resembling a rhombic dodecahedron. The pyramidal faces *e* are curved. H = 5–5.5. Sp. gr. 3.85–3.97.

Analysis: Pricetown, Berks County. Chocolate brown crystals in magnetite. Wetherill, 1853, 349.

SiO_2	34.07
ZrO_2	63.50
Fe_2O_3	2.02
H_2O	0.50
	100.09
Sp. gr.	4.595

LOCALITIES: *Berks County:* Bernharts, Pricetown, and Trexler mica mine (Alsace); *Bucks County:* Finney's quarry, Neshaminy Falls, Siles, and Vanartsdalen's quarry; *Chester County:* Chester Springs, Copesville, Pughtown, Springton, Octoraro Creek, West Chester (Bath Springs), and Willowdale; *Delaware County;* Avondale (cyrtolite), Blue Hill, Boothwyn (cyrtolite), Brandywine Summit, Painter's farm on Dismal Run, and Morgan Station (cyrtolite); *Lehigh County:* Macungie; *Montgomery County:* Lafayette, Willow Grove; *Northampton County:* Chestnut Hill (gray or brownish crystals, 5 cm. long); *Philadelphia:* Broad Street and Olney Avenue (cyrtolite,) Bridesburg (colorless crystals in Delaware River sands), Comley's quarry (Mt. Airy, cyrtolite), Fairmount Park, and in the Schuylkill River sands and gravels.

TOPAZ

$Al_2F_2SiO_4$ ORTHORHOMBIC

Colorless, white, gray, yellow, greenish, bluish. Transparent to subtranslucent. Luster: vitreous. Form: columnar masses; prismatic crystals. H = 8. Brittle. Sp. gr. 3.4–3.65.

LOCALITY: *Northampton County:* Chestnut Hill? (small cream yellow crystals).

ANDALUSITE

Al_2SiO_5 ORTHORHOMBIC

Color: white, pearl gray. Streak: uncolored. Translucent to opaque. Luster: vitreous Form: rough square prismatic crystals; massive, columnar. H = 7.5. Brittle. Sp. gr. 3.16–3.20.

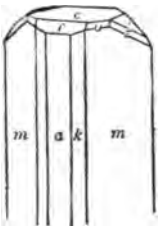
Crystallography: Orthorhombic; a:b:c = 0.9861 : 1 : 0.7025.

$p_0 : q_0 : r_0 = 0.7124 : 0.7025 : 1$.

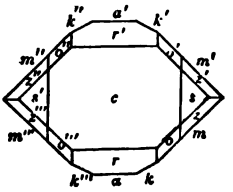
Forms: *a* (100), *b* (010), *c* (001), *k* (210), *m* (110), *r* (101), *s* (011), *o* (111), *z* (121), Upper Providence, Delaware County, (Dana, 1872, 473). Cleavage: *m* distinct, *a* less perfect, *b* in traces. Fracture: uneven, subconchoidal. Crystals may have a fibrous or radiated structure.

Composition: Al_2SiO_5; SiO_2 36.8, Al_2O_3 63.2, = 100. A small amount of Fe_2O_3 is usually present.

LOCALITIES: *Delaware County:* Avondale, Black Horse, Boothwyn, Franklin Paper Mills, Hunter's farm (Upper Providence), Leiperville, Lewis's farm (Nether Providence), Swarthmore, opposite Swarthmore College, Worrall's farm in Marple and Upper Providence townships (crystals measuring 6 × 23 cm. and groups up to 60 pounds have been found on this farm in Upper Providence township).



59



60

Figs. 59–60. Andalusite, Upper Providence, Delaware County (*Dana*).

SILLIMANITE

Al_2SiO_5 ORTHORHOMBIC

Color: white, gray, grayish-green, grayish-brown. Streak: uncolored. Transparent to translucent. Luster: vitreous or silky. Form: fibrous or columnar masses, often radiated; acicular crystals. H = 6–7. Sp. gr. 3.23–3.24.

Crystallography: Orthorhombic; Forms: *a* (100), *b* (010), *m* (110), *k* (230). Cleavage: *b* very perfect. Fracture: uneven.

Composition: Al_2SiO_5; SiO_2 36.8, Al_2O_3 63.2, = 100.

Synonyms: fibrolite. bucholzite.

Analyses: Chester, Delaware County. A. Silliman, Jr., 1849, 388. B. Erdmann, 1842 22. C. Thomson, 1828, 41.

	A	B	C
SiO_2	34.31	40.05	46.40
Al_2O_3	64.43	58.88	52.92
Fe_2O_3	——	0.74	tr.
MnO	tr.	——	——
MgO	0.52	——	——
Ignition	——	0.40	——
	99.26	100.07	99.32
Sp. gr.		3.239	3.193

	D	E	F	G
SiO_2	37.37	36.98	34.80	35.68
Al_2O_3	(60.52)	62.85	59.77	60.29
Fe_2O_3	0.90	tr.	0.73	0.72
MnO	0.10	——	——	——
MgO	0.25	——	——	0.29
CaO	0.38	——	——	——
Li_2O	——	tr.	——	tr.
Na_2O	——	0.24	n. det.	0.41
K_2O	——	0.22	n. det.	0.96
Ignition	0.48	0.66	2.05	1.78
Corundum	——	——	2.20	——
	100.00	100.95	99.55	100.13
Sp. gr.	3.286		3.157	

D. Pseudomorphous after corundum; Mineral Hill, Delaware County. Genth, 1873, 380. E. Paramorphous after andalusite; Darby, Delaware County. Genth, 1875, 100. F. Unionville, Chester County. Least altered "lesleyite." Genth, 1873, 389, analysis by Koenig. G. Unionville, Chester County. Least altered "lesleyite." Genth, 1873, 389.

LOCALITIES: *Chester County:* Nevin's quarry, Pierce's Paper Mill (Kennett), and south of Phillip's quarries; *Delaware County:* Black Horse, Brandywine Summit, Chester, Custer's farm (Darby), Darby, Green's farm near Upland, Kellyville, Mineral Hill, Morgan Station, Moore, near Peter's Mill dam (Aston), Ridleyville, Tyler's farm (Middletown), West Conshohocken? and Worrall's farm (Upper Providence, paramorphous after andalusite); *Philadelphia:* Cobb's Creek, Fairmount Park, Frankford, Falls of Schuylkill, Germantown, Hestonville, West Philadelphia, Wissahickon Station, Wissahickon Valley, and Wingohocking Creek.

CYANITE

Al_2SiO_5 TRICLINIC

Color: blue, green, gray, white, black. Streak: uncolored. Transparent to translucent. Luster: vitreous to pearly. Form: coarsely bladed or acicular masses, or in bladed crystals rarely terminated. H = 5–7.25. Sp. gr. 3.56–3.67.

Crystallography: Triclinic:

$a:b:c = 0.8991:1:0.6968$; $\alpha = 90° 23'$, $\beta = 100° 18'$, $\gamma = 106° 1'$.

$p_0:q_0:r_0 = 0.862:0.7132:1$; $\lambda = 86° 36'$, $\mu = 79° 10'$, $\nu = 73° 38'$.

Common forms: *a* (100), *b* (010), *c* (001), M ($1\bar{1}0$), *m* (110). Cleavage: *a* very perfect, *b* less so; parting parallel to *c* (a glide plane).

Composition: Al_2SiO_5; SiO_2 36.8, Al_2O_3 63.2, = 100.

Analyses: A. Moore, Delaware County. Light to dark blue. Eyerman, 1911, 7. B. Cope's Bridge, Chester County. Grayish-green crystals. Eyerman, 1911, 7. C. Cope's Bridge, Chester County. Light green to bluish-green bladed prisms. Eyerman, 1911, 7.

	A	B	C
SiO_2	38.01	35.63	37.96
Al_2O_3	60.86	58.65	60.80
Fe_2O_3	1.16	4.91	1.30
Ignition	0.61	——	——
	100.64	99.19	100.06
Sp. gr.	3.621	3.569	3.600

LOCALITIES: *Bucks County:* Hulmeville; *Chester County:* Avondale, south of Bailey's farm (East Marlboro), near Bailey's quarry (West Marlboro), Black Horse Inn, near Cope's quarry, Copesville, Embreeville, near Logan's quarry, London Grove, Marshallton, Minorcus Hill, and Pocopson; *Delaware County:* Adele, Chelsea, Chester, Custer's farm (Darby township), Darby, Dickinson's Mill, Leiperville, Mineral Hill, Moore, Ridleyville, Trainer, and Ward's quarry; *Philadelphia:* Chestnut Hill, Fairmount Park, Germantown, Logan, Shawmont, Vereeville, and Wissahickon Valley.

DATOLITE

$Ca(B,OH)SiO_4$ MONOCLINIC

Color: pale green, gray, yellow. Streak: white. Transparent to translucent. Luster: vitreous. Form: crystals, druses; massive, granular or compact. H = 5–5.5. Brittle. Sp. gr. 2.9–3.0.

Crystallography: Monoclinic: $a:b:c = 0.6329:1:0.6345$; $\beta = 90° 9'$.

$p_0:q_0:r_0 = 1.0025:0.6345:1$; $\mu = 89° 51'$.

Common forms: *a* (100), *c* (001), *m* (110), *n* (111), m_2 (011), ϵ ($\bar{1}12$), μ ($\bar{1}14$). Fracture: conchoidal; uneven.

Composition: $Ca(B,OH)SiO_4$; SiO_2 37.6, B_2O_3 21.8, CaO 35.0, H_2O 5.6, = 100.

LOCALITIES: *Berks County:* Fritz Island, and Jacksonwald.

GADOLINITE

$Be_2Fe(YO)_2(SiO_4)_2$ MONOCLINIC

Color: black, greenish-black, brown; in thin splinters nearly transparent. Streak:

greenish-gray. Luster: vitreous to greasy. Form: massive; rough crystals. H = 6.5–7. Brittle. Sp. gr. 4.0–4.5.

Composition: $Be_2Fe(YO)_2(SiO_4)_2$; SiO_2 23.9, Y oxides 51.8, FeO 14.3, BeO 10.0, = 100.

LOCALITY: *Philadelphia:* Rittenhouse quarry?

ZOISITE

$Ca_2(AlOH)Al_2(SiO_4)_3$ ORTHORHOMBIC

Color: grayish-white, gray, yellowish-brown, pink to rose-red (thulite), greenish. Streak: uncolored. Transparent to subtranslucent. Luster: vitreous; on cleavage surfaces pearly. Form: massive, columnar to compact; rarely in striated prismatic crystals.

Composition: $Ca_2(AlOH)Al_2(SiO_4)_3$; SiO_2 39.7, Al_2O_3 33.7, CaO 24.6, H_2O 2.0, = 100. Al is sometimes replaced by Fe, and with increase of the latter the mineral passes into epidote.

Varieties: Thulite,— rose-red, fragile; sp. gr. 3.124. Unionite— white to yellowish-white cleavage masses from Unionville, Chester County. (Silliman, Jr., 1849, 384; Smith and Brush, 1853, 211.)

Analyses: A. Thulite; Deshong's quarry, Leiperville, Delaware County. Koenig, 1878, 83. Mean of 2 analyses. B. Thulite; Deshong's quarry, Leiperville, Delaware County. Eyerman, 1911, 8. C. Bath Springs, Chester County. Brown, radiating prismatic crystals. Eyerman, 1911, 8. D. "Unionite." Unionville, Chester County. Brush, 1858, 170. E. "Unionite." Unionville, Chester County. Silliman, Jr., 1849, 385. F. Lafayette, Montgomery County. Grayish and brownish crystals and crystalline masses. Genth, 1875, 81.

	A	B	C	D	E	F
SiO_2	40.70	41.72	41.01	40.61	44.15	40.30
TiO_2	——	tr.	——	——	——	——
Al_2O_3	33.30	30.20	30.25	33.44	42.26	28.31
Fe_2O_3	2.40	3.19	——	0.49	——	5.47
FeO	0.70	0.18	1.14	——	——	——
MnO	0.43	tr.	——	——	——	0.47
CaO	19.70	22.29	24.30	24.13	——	22.93
MgO	0.15	tr.	tr.	tr.	7.36	0.66
Na_2O	——	——	——	——	1.73	——
H_2O, (Ign.)	2.40	2.21	2.62	2.22	3.53	1.86
F	——	——	——	——	——	——
	99.78	99.79	99.32	100.69	99.13	100.00
Sp. gr.		3.519	3.831	3.299	3.2984	

LOCALITIES: *Chester County:* Corundum Hill (Newlin, unionite), Sylmar, French Creek mines, Pierce's Paper Mill (Kennett), and West Chester (Bath Springs); *Delaware County:* Avondale (thulite), and Leiperville (thulite, rose red to pale pink, with grossularite); *Philadelphia:* Fairmount Park, Germantown, and Prince's quarry.

EPIDOTE

$\left\{\begin{matrix} m\ (Ca_2(AlOH)Al_2(SiO_4)_3 \\ n Ca_2(FeOH)Al_2(SiO_4)_3 \end{matrix}\right.$ MONOCLINIC

Color: dark green, greenish-black, yellowish-green to brownish-green. Streak: uncolored, grayish. Subtranslucent. Luster: vitreous; on *c* pearly or resinous. Form: columnar aggregates; granular masses; prismatic crystals. H = 6–7. Brittle. Sp. gr. 3.25–3.5.

Crystallography: Monoclinic; a:b:c = 1.5807:1:1.8057, β = 115° 24′.

$p_0:q_0:r_0$ = 1.1423:0.6312:1, μ = 64° 36′.

Common forms: *a* (100), *b* (010), *c* (001), *u* (120), *r* ($\bar{1}01$), *n* ($\bar{1}11$). Habit: prismatic elongated in the direction of the b axis, and terminated at one end only. Cleavage: *c* perfect, *a* imperfect.

Analyses: A. Near Perkasie, Bucks County. Nodular, in Triassic shales. Eyerman, 1911, 9. B. Kober's copper mine, Sumneytown, Montgomery County. Olive-green. Eyerman, 1911, 9. C. Clark's quarry, Frankford, Philadelphia. Dark olive-green crystals. Eyerman, 1911, 9.

	A	B	C
SiO_2	38.98	40.00	37.77
Al_2O_3	25.29	22.03	23.20
Fe_2O_3	8.25	20.24	10.57
FeO	1.11	0.73	0.82
MnO	0.13	0.56	0.59
CaO	23.29	16.10	23.55
H_2O	2.23	1.10	3.23
	99.28	100.76	99.73
Sp. gr.	3.397	3.491	3.401

LOCALITIES: *Adams County:* Gettysburg, and Hamiltonban; *Berks County:* Antietam Reservoir, Bernharts, Boyertown, Fleetwood, Longswamp Township, and Mt. Penn; *Bucks County* New Hope, Perkasie (locally abundant as nodules in shales metamorphosed by diabase intrusions), and Reeder; *Chester County:* Avondale, south of Bailey's farm (East Marlboro), Bailey's quarry (West Marlboro), Cloud's farm (Kennett), Cope's quarry, Hopewell mines, Kimberton, Marlboro, Mullen's farm (Kennett), Pierce's Paper Mill (Kennett), Taylor's quarry, and Warwick mines; *Delaware County:* Avondale, Bain's quarry, Morton; *Lancaster County:* New Holland; *Lehigh County:* South Mountain; *Montgomery County:* Hendricks Station, Perkiomenville, and Sumneytown; *Northampton County:* Chestnut Hill, and Redington; *Philadelphia:* Fairmount Park, Frankford, Germantown, Overbrook, Prince's quarry, O'Neill's quarry, Rittenhouse quarry, and Wingohocking Creek.

PIEDMONTITE

$Ca_2(AlOH)(Al,Mn,Fe)_2(SiO_4)_3$ MONOCLINIC

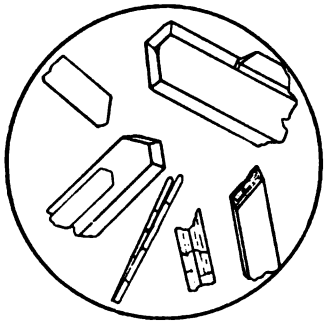
Color: reddish-brown, in very thin splinters columbine-red. Streak: reddish. Opaque to subtranslucent. Luster: vitreous. Form: fibrous aggregates; small prismatic crystals. H = 6.5. Fragile. Sp. gr. 3.404.

Crystallography: Monoclinic; $a:b:c = 1.6100:1:1.8326$; $\beta = 115° 21'$.

$p_0:q_0:r_0 = 1.1383:1.6562:1$; $\mu = 64° 39'$.

Forms: *a* (100), *b* (010), *c* (001), *m* (110), *e* (101), *i* ($\bar{1}02$), *r* ($\bar{1}01$), *n* ($\bar{1}11$). Habit: prismatic, elongated parallel to the *b* axis; faces usually dull.

Composition: $Ca_2(AlOH)(Al,Mn,Fe)_2(SiO_4)_3$; with Al:Fe:Mn = 3:2:1, SiO_2 33.6, Al_2O_3 14.3, Fe_2O_3 14.9, Mn_2O_3 14.7, CaO 20.9, H_2O 1.7, = 100.



61

62

Figs. 61–62. Piedmontite, Buchanon Valley, Adams County (*Williams*); 61, Piedmontite needles from scheelite, × 120; 62, Microscopic piedmontite in minute veins with secondary quartz and surrounded by rims of epidote, × 20.

Analyses: A. West flank of Pine Mountain, 1 mile north of Charmian Station, Adams County. Deep carmine spherulitic aggregates of needles with quartz, filling veins in rhyolite. Pleochroism intense; X = yellow to orange, Y = amethyst, Z = carmine; Z>Y = X. SiO_2

10% too high due to presence of quartz. Williams, 1893, 54. (R_2O_3 = rare earths). B. Recalculated after deducting quartz. A determination of SiO_2 by Hillenbrand on finely pulverized material separated by methylene iodide (Sp. gr. 3.32) gave SiO_2 40.08%. The microscope still showed the presence of some quartz. Williams, 1893, 54.

	A	B
SiO_2	47.37	37.37
Al_2O_3	18.55	22.07
Ce_2O_3	0.75	0.89
R_2O_3	1.28	1.52
Fe_2O_3	4.02	4.78
Mn_2O_3	6.85	8.15
MnO	1.92	2.285
CaO	15.82	18.825
MgO	0.25	0.30
K_2O	0.68	0.81
Na_2O	0.23	0.27
H_2O	2.08	2.48
CuO	0.11	0.13
PbO	0.14	0.17
	100.05	100.05

LOCALITIES: *Adams County:* in rhyolite and aporyolite in the Buchanon Valley, on Pine Mountain, and near Monterey.

ALLANITE

$(Ca,Fe)_2(AlOH)(Al,Ce,Fe)_2(SiO_4)_3$ MONOCLINIC

Color: pitch-black, often coated with a brown weathering product. Translucent to opaque. Luster: submetallic, pitchy or resinous. Form: massive, imbedded grains, rough tabular crystals. H = 5.5–6. Brittle. Sp. gr. 3.5–4.2.

Crystallography: Monoclinic; $a:b:c = 1.5527:1:1.7780$; $\beta = 124° 00'$.

$p_0:q_0:r_0 = 1.1451:1.6114:1$; $\mu = 65° 00'$.

Common forms: *a* (100), *c* (001), *m* (100), *n* (111), *n* ($\bar{1}11$), *r*($\bar{1}01$), *i* ($\bar{1}02$). Habit: tabular parallel to *a*. Cleavage: *a*, *c*, in traces.

Synonym: orthite.

Analyses: A. East Bradford, Chester County. Black, massive, altered on the surface. Engström, 1877. B. East Bradford, Chester County. Rammelsberg, 1850, 285. C. Pricetown, Berks County. Pitch-black, massive. Genth, 1855, 21. Mean of 2 analyses by Peter D. Keyser. D. Bethlehem, Lehigh County. Large imperfect crystals, blackish-brown. Genth 1855, 21; average of 2 analyses by Peter D. Keyser.

	A	B	C	D
SiO_2	31.56	31.86	32.89	33.31
ThO_2	0.31	——	——	——
Al_2O_3	16.77	16.87	12.49	14.34
Fe_2O_3	5.74	3.58	7.33	10.83
Ce_2O_3	18.15	21.27	15.68	13.42
$(Di,La)_2O_3$	2.71	2.40	10.10	2.70
Y_2O_3	1.65	——	——	——
FeO	9.08	12.26	9.02	7.20
MnO	1.15	——	0.25	——
CaO	9.35	10.15	7.12	11.28
MgO	——	1.67	1.77	1.23
Na_2O	——	——	0.09	0.41
K_2O	0.37	——	0.14	1.33
H_2O	2.25	1.11	2.49	3.01
	99.09	101.17	99.37	99.06
Sp. gr.	3.48	3.535	3.831	3.491

LOCALITIES: *Berks County:* Pricetown, and Trexler mica mine (Alsace); *Chester County:* Chester Springs, Comley Hall (East Bradford, black masses coated with a brown weathering product), Corundum Hill (Newlin), Minorcus Hill, and Pughtown; *Delaware County:* Lenni, and Morton; *Northampton County:* Lehigh Mountain (large black masses), and Redington; *Philadelphia:* Hoffman's quarry, and McCrea's quarry.

AXINITE

$HCa_2(Fe,Mn)Al_2B(SiO_4)_4$ TRICLINIC

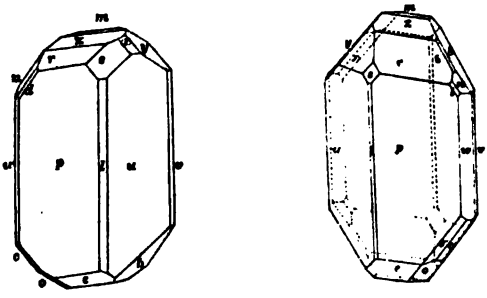
Color: clove-brown, pearl-gray, honey-yellow, greenish-yellow. Streak: uncolored. Transparent to subtranslucent. Luster: vitreous. Form: tabular crystals, with acute-edges. H = 6.5–7. Brittle. Sp. gr. 3.271–3.294.

Crystallography: Triclinic.

$a:b:c = 0.7812:1:0.9771$; $\alpha = 91° 49'$, $\beta = 82° 1'$, $\gamma = 102° 38'$.

$p_0:q_0:r_0 = 1.2810:0.9915:1$; $\lambda = 90° 5'$, $\mu = 97° 46'$, $\nu = 102° 30'$.

Forms: *l* (100), *v* (010), *m* (001), *u* (110), *p* ($1\bar{1}0$), *x* (111), *w* ($1\bar{3}0$), *r* ($1\bar{1}1$), *z* ($1\bar{1}2$), *e* ($\bar{1}11$), *s* (201), *y* (021), *c* ($\bar{1}31$), *σ* ($\bar{2}41$), *d* ($2\bar{4}1$), *n* ($1\bar{3}1$), *b* ($0\bar{2}1$), *δ* ($1\bar{3}2$), *o* ($\bar{1}32$), *φ* ($\bar{1}33$). Bethlehem, Lehigh County (Frazier, 1882, 439–447). Cleavage: *v* distinct; also *m*, *w*. Fracture: conchoidal.



63 64

Figs. 63–64. Axinite, Campbell's Hump, Northampton County (*Frazier*).

Analyses: Leiper's quarry, Avondale, Delaware County. Wherry, 1915, 511. A. Yellow plates. J. E. Whitfield, analyst. B. Determination of B_2O_3 in the above by Wherry. C. Theoretical composition (Mn:Fe = 4:1). D. Mixture of axinite and zoisite. MnO and SiO_2 (probably too low). Analysis by Wherry. E. Mixture of axinite and zoisite analyzed by Whitfield. F. Theoretical composition of axinite (Mn:Fe = 4:1) mixed with 20% of zoisite.

	A	B	C	D	E	F
SiO_2	42.24		42.28	37.41	42.92	41.85
Al_2O_3	18.78		17.91	(22.93)	22.64	20.54
B_2O_3	3.14	6.04	6.14	5.45	n. det.	5.12
FeO	3.80		2.49	3.39	3.16	5.19
MnO	10.12		9.94	3.26	5.19	5.17
CaO	19.98		19.66	22.47	20.00	20.48
MgO	1.01		——	2.68	1.55	——
K_2O	——		——	0.65	n. det.	——
H_2O	0.57		(1.58)	1.76	n. det.	1.65
	99.64		100.00	100.00	(95.46)	100.00

LOCALITIES: *Delaware County:* Avondale, yellow plates with thulite; *Northampton County:* Campbell's Hump, colorless to pale brown crystals.

PREHNITE

$H_2Ca_2Al_2(SiO_4)_3$ ORTHORHOMBIC

Color: green, gray, white. Subtransparent to translucent. Streak uncolored. Luster: vitreous. Form: druses of crystals grouped in mammillary, globular or stalactitic forms. H = 6–6.5. Brittle. Sp. gr. 2.80–2.95.

Crystallography: Orthorhombic; a : b : c = 0.8405:1:1.1207.

$p_0:q_0:r_0 = 1.3334:1.1207:1.$

Common forms: *a* (100), *b* (010), *c* (001), *m* (110), *o* (061). Cleavage: *c* distinct. Fracture: uneven.

Composition: $H_2Ca_2Al_2(SiO_4)_3$; SiO_2 43.7, Al_2O_3 24.8, CaO 27.1, H_2O 4.4, = 100.

Analyses: A. Cornwall, Lebanon County. White, yellowish, and brownish-white crystal aggregates on magnetite. Genth, 1882, 401. B. Rockhill, Bucks County. Light green. Eyerman, 1911, 8.

	A	B
SiO_2	42.40	42.99
Al_2O_3	20.88	21.12
Fe_2O_3	5.54	2.85
MnO	——	tr.
CaO	27.02	27.97
MgO	tr.	——
Na_2O, K_2O	tr.	——
H_2O	4.01	4.57
	99.85	99.50
Sp. gr.		2.981

LOCALITIES: *Adams County:* Marsh Creek; *Berks County:* Birdsboro, Gickerville, and Jacksonwald; *Bucks County:* Rock Hill: *Lebanon County:* Cornwall; *Philadelphia:* Rittenhouse quarry.

CHONDRODITE

$Mg_3[Mg(F,OH)]_2[SiO_4]_2$ MONOCLINIC

Color: yellow, red. Subtransparent to translucent. Luster: vitreous. Form: imbedded grains. H = 6–6.5. Brittle. Sp. gr. 3.1–3.2.

LOCALITIES: *Chester County:* Harvey's quarry (Pennsbury); *Lancaster County:* Ephrata?

ILVAITE

$CaFe_2(FeOH)(SiO_4)_2$ ORTHORHOMBIC

Color: iron-black, or dark grayish-black. Streak: black. Opaque. Luster: submetallic. Form: columnar, compact, massive. Prismatic crystals with prism face vertically striated.

Composition: $CaFe_2(FeOH)(SiO_4)_2$; SiO_2 29.3, Fe_2O_3 19.6, FeO 35.2, CaO 13.7, H_2O 2.2, = 100.

LOCALITIES: *Philadelphia:* Fairmount Park? and Flat Rock?

CALAMINE

$H_2Zn_2SiO_5$ ORTHORHOMBIC

Colorless, white, yellowish, light blue or greenish. Streak: white. Transparent to translucent. Luster: Vitreous. Form: druses of minute crystals in botryoidal or sheaf-like aggregates. H = 4.5–5. Brittle. Sp. gr. 3.40–3.50.

Crystallography: Orthorhombic, hemimorphic; a:b:c = 0.7835:1:0.4778.

$p_0:q_0:r_0 = 0.6098:0.4778:1.$

Common forms: *c* (001), *b* (010) vertically striated; *m* (110), *i* (031), *t* (301), *e* (01$\bar{1}$), *v* (12$\bar{1}$). Habit: tabular parallel to *b*. Cleavage: *m* perfect.

Composition: $H_2Zn_2SiO_5$; SiO_2 25.0, ZnO 67.5, H_2O 7.5, = 100.

Analyses: A. Ueberroth mine, Friedensville, Lehigh County. Eyerman, 1889, 29. B. Wheatley mine, Chester County. Eyerman, 1911, 9–10.

	A	B
SiO_2	24.32	24.27
Fe_2O_3	2.12	1.96
ZnO	65.05	65.90
H_2O	7.86	7.80
	99.35	99.93
Sp. gr.		3.409

LOCALITIES: *Blair County:* Keystone zinc mine near Birmingham; *Chester County:* Wheatley mines, silky tufts and botryoidal masses; *Lancaster County:* Bamford, and Pequa mines; *Lehigh County:* Friedensville, small crystals in druses and radiating groups; *Montgomery County:* Ecton and Perkiomen mines; *Northampton County:* Dryland Station; *Northumberland County:* Sunbury.

TOURMALINE

$R^I_9Al_3(B,OH)_2Si_4O_9$ RHOMBOHEDRAL

Color: commonly black; brownish-black; blue (indicolite), green, red (rubellite), yellow, white, rarely colorless. Streak: uncolored. Transparent to opaque. Luster: vitreous to resinous. Form: prismatic crystals; columnar masses of crystals, often radiating. H = 7–7.5. Very brittle. Sp. gr. 2.98–3.20.

Crystallography: Rhombohedral, hemimorphic; c = 0.4477, p_0 = 0.2985. Common forms: *a* (11$\bar{2}$0), *m* (10$\bar{1}$0), *r* (10$\bar{1}$1), *e* (01$\bar{1}$2), *o* (02$\bar{2}$1), *c* (0001), *t* (21$\bar{3}$1). Habit: prismatic, prism faces striated vertically. Cleavage: *a*, *r*, difficult. Fracture: subconchoidal to uneven.

Composition: $R^I_9Al_3(B,OH)_2Si_4O_{19}$; R^I = Fe, Mn, and the alkalies: Na_2, Li_2, K_2, or the alkali earths: Mg, Ca. The tourmalines may be classified chemically into iron tourmaline (deep black), alkali tourmaline (red to green), or magnesian tourmaline (yellowish brown, brownish-black, colorless).

Analyses: A. Ball's quarry, Newlin, Chester County. Black crystals. Eyerman, 1911, 10. B. Avondale, Delaware County. Black crystals. Eyerman, 1911, 10. C. Lehigh Mountain, 2 miles south of Allentown, Lehigh County. Brownish black. E. F. Smith., Am. Chem. J., V, 1883, 275. D. Above Devil's Oven, Bushkill Creek, west of Easton, Northampton County. Crystals. Eyerman, 1904, 45–46. E. "Texas, Lancaster County." Black. Rammelsberg, 1850, 478.

	A	B	C	D	E
SiO_2	36.85	36.82	39.41	35.57	38.47
TiO_2	1.72	0.69	——	0.18	——
B_2O_3	10.85	10.60	9.00	10.10	8.48
Al_2O_3	23.98	31.52	19.46	24.72	34.56
Fe_2O_3	11.58	8.30	8.44	1.17	3.31
FeO	4.32	2.47	7.00	9.40	——
MnO	5.39	0.72	——	——	0.09
CaO	1.96	2.43	3.49	3.42	0.71
MgO	——	——	2.14	8.29	9.11
Na_2O	0.36	0.78	——	2.10	2.00
K_2O	0.18	1.53	——	0.40	0.73
Li_2O	——	——	——	tr.	——
F	——	——	——	n. det.	2.36
P_2O_5	——	——	——	——	0.20
H_2O (Ign.)	3.51	3.81	2.19	4.23	3.30
	100.70	99.67		99.58	103.32
Sp. gr.				2.991	3.043

LOCALITIES: *Bucks County:* Glenlake, Hulmeville, Janney, Morrisville, Neshaminy Falls, New Hope, Newportville; *Chester County:* Atglen, Avondale (black and brown), Bailey's farm (East Marlboro, black, brown, yellow, and green), Sylmar, Brinton's farm (Thornbury), Brinton's quarry (Westtown), Coatesville, Corundum Hill (Newlin, black masses, greenish or bluish transparent crystals in diaspore and margarite), Doe Run quarries (brown), Edward's

quarry (Newlin), French Creek mines; Johnson and Patterson's quarry (Newlin, large black crystals), Kennett Square, Lenape, Lewisville, Logan's quarry (yellow), Marlboro, Minorcus Hill, Nevin's quarry (yellow and brown), Osborn Hill, Oxford, Parkesburg, Phillip's quarries (brown), Pugh's farm (East Nottingham), Pusey's quarries, and Sadsburyville; *Delaware County:* Adele, Avondale (black prismatic crystals often in sections cemented by quartz, or with quartz cores), Black Horse, Boothwyn (black crystals, 10 cm. long), Bunting's quarry, Burk's quarry, Crozierville, Custer's farm (Darby), Dickinson's Mill, Franklin Paper Mills, Green's farm near Upland, Kellyville, Leiperville (black crystals, 12 × 3 cm., rarely pale green or red), Lewis's farm (Nether Providence), Llanerch, Morgan Station (acicular black crystals in milky quartz), Morton, Painter's farm on Dismal Run, Rockdale, Shaw and Esrey's quarry in Chester, Trainer (brilliant black crystals), Upper Darby, Village Green (acicular black crystals in milky quartz), Ward's quarry, Worrall, and Worrall's farm (Marple and Upper Providence); *Lancaster County:* Gap mine, Herrville and Texas (green, in sericite); *Lehigh County:* Mountainville, and Shimersville; *Montgomery County:* Conshohocken, Edge Hill, Flourtown, Harpers Station, Mogeetown, Ogontz, and Wyncote; *Northampton County:* Chestnut Hill, and Redington; *Philadelphia:* Branchtown, Bustleton, Cobb's Creek, Fairmount Park, Falls of Schuylkill, Fox Chase, Frankford, Germantown, Logan, Manayunk, O'Neill's quarry (rubellite?), Overbrook, Rittenhouse quarry, Ryers, Shawmont, Tabor, Tacony Creek, Vereeville, West Philadelphia, Wingohocking Creek, and Wissahickon Valley; *York County:* Rossville.

STAUROLITE

$FeAl_5(OH)(SiO_6)_2$ ORTHORHOMBIC

Color: dark reddish-brown to brownish-black. Streak: uncolored or grayish. Translucent to opaque. Luster: subvitreous to resinous. Form: prismatic crystals, commonly in cruciform twins. H = 7–7.5. Brittle. Sp. gr. 3.65–3.75.

Crystallography: Orthorhombic: $a:b:c = 0.6942:1:0.9795$.

$$p_0:q_0:r_0 = 1.4110:0.9795:1.$$

Common forms: *m* (110), *b* (010), *c* (001), *r* (101). Habit: prismatic. Twins cruciform: twin planes *x* (032), *z* (232), or *y* (230)(rare).

LOCALITIES: *Chester County:* near Logan's quarry, and near Taylor's quarry; *Delaware County:* Adele, Ardmore, Cream Valley, Dickinson's Mill, Edgemont, Franklin Paper Mills, Glen Riddle, Llewellyn Mills, Mineral Hill, Morgan Station, Mullen's quarries, and St. David's; *Montgomery County:* Edge Hill? *Philadelphia:* Fairmount Park, Frankford, Prince's quarry? Roxborough, and Wissahickon Valley.

HYDROUS SILICATES

APOPHYLLITE	$(H,K)_2CaSi_2O_6.H_2O$	Tetragonal
	ZEOLITES	
HEULANDITE	$CaAl_2Si_6O_{16}.5H_2O$	Monoclinic
STILBITE	$(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$	Monoclinic?
EPIDESMINE	$(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$	Orthorhombic
CHABAZITE	$(Ca,Na_2)Al_2Si_4O_{12}.6H_2O$	Rhombohedral
LAUMONTITE	$CaAl_2Si_4O_{12}.4H_2O$	Monoclinic
GISMONDITE	$(K_2,Ca)Al_2Si_3O_{10}.4H_2O$	Monoclinic
NATROLITE	$Na_2Al_2Si_3O_{10}.2H_2O$	Orthorhombic
SCOLECITE	$Ca_2Al_2Si_3O_{10}.3H_2O$	Monoclinic
MESOLITE	$\begin{cases} m\ Na_2Al_2Si_3O_{10}.2H_2O \\ n\ CaAl_2Si_3O_{10}.3H_2O \end{cases}$	Monoclinic?
THOMSONITE	$CaAl_2Si_2O_8.2^1/_2H_2O$	Orthorhombic
ANALCITE	$NaAlSi_2O_6.H_2O$	Isometric

APOPHYLLITE

$(H,K)_2CaSi_2O_6.H_2O$ TETRAGONAL

Colorless, white, grayish, greenish, or yellowish. Transparent. Luster: vitreous, of *c* pearly. Form: square prisms or tabular crystals, pseudo-cubic; rarely pyramidal. H = 4.5–5. Brittle. Sp. gr. 2.3–2.4.

Crystallography: Tetragonal; c, $p_0 = 1.2515$. Common forms: *a* (100), *m* (110), *r* (210), *y* (310), *c* (001), *p* (111). Habit: square prismatic, tabular, acute pyramidal; *a* is vertically striated. Cleavage: *c* highly perfect, *m* less so.

Analyses: A. Clark's quarry, Frankford, Philadelphia. Eyerman, 1911, 11. B. McKinney's quarry, Germantown, Philadelphia. Eyerman, 1911, 11. The mineral was somewhat altered. C. French Creek mines, Chester County. Knerr and Schoenfeld, VI, 1885, 413. D. French Creek mines, Chester County. Eyerman, 1889, 30. E. French Creek mines, Chester County. Light salmon-pink. Eyerman, 1911, 11.

	A	B	C	D	E
SiO_2	52.64	50.12	51.88	51.63	51.71
Fe_2O_3	——	3.91	——	——	0.57
CaO	25.01	23.78	25.31	25.42	25.02
Na_2O	——	2.02	——	——	0.46
K_2O	5.32	1.07	6.30	6.27	4.34
H_2O	16.74	18.64	16.80	16.58	17.36
	99.71	99.54	100.29	99.90	99.46
Sp. gr.	2.381			2.350	2.421

F–G. Railroad cut east of Reading (probably Birdsboro) Berks County. Colorless to white crystals. Smith, 1910, 538. H. Fritz Island, Berks County. Sadtler, Jr., 1883, 357.

	F	G	H
SiO_2	52.03	51.95	51.02
Al_2O_3	0.28	2.94	——
Fe_2O_3	tr.		1.49
CaO	25.11	23.68	24.40
MgO	——	0.36	——
Na_2O	0.71	0.34	——
K_2O	5.13	4.47	5.87
F	——	——	0.40
H_2O	17.43	15.81	16.75
	100.69	99.55	99.93
Sp. gr.	2.399	2.37	2.5

LOCALITIES: *Berks County:* Birdsboro, Fritz Island, and Gickerville; *Chester County:* French Creek mines; colorless, white, yellow or pink, tabular or pyramidal crystals; crystals measure up to 5 cm., and often occur in quite large groups; *Delaware County:* Lenni; *Philadelphia:* Frankford, and Rittenhouse quarry.

STILBITE

$(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$ MONOCLINIC?

Colorless, white, yellow, brown, red. Streak: uncolored. Transparent to translucent. Luster: vitreous, *b* pearly. Form: sheaf-like aggregates of radiating or divergent crystals of tabular habit. H = 3.5–4. Sp. gr. 2.094–2.205.

Crystallography: Monoclinic?[47] a:b:c = 0.7623:1:1.1940; $\beta = 50° 50'$. Common forms: *c* (001), *b* (010), *m* (110). Crystals are commonly twinned, twin-plane *c* making them pseudo-orthorhombic. Habit: usually tabular parallel to *b*. Cleavage: *b* perfect.

Composition: $(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$; with $Ca:Na_2 = 6:1$, SiO_2 57.4, Al_2O_3 16.3, CaO 7.7, Na_2O 1.4, H_2O 17.2, = 100.

Analyses: A. Frankford, Philadelphia. White, radiating crystals. Genth, 1876, 226; Walter A. Fellows, analyst. B. McKinney's quarry, Germantown, Philadelphia. White radiating crystals. Eyerman, 1904, 44. C. French Creek mines, Shaft No. 1, Chester County. Crystals, with calcite. Eyerman, 1889, 32. D. Railroad cut east of Reading (probably Birds-

[47] Lasaulx, Zeit. Kryst., 2, 576, 1878; Goldschmidt makes the mineral orthorhombic:
a:b:c = 0.928 : 1 : 0.756
$p_0 . q_0 : r_0$ = 0.8146:0.756:1.

boro), Berks County. Radiating crystals. Smith, 1910, 539. E. Wheatfield mine, Berks County. Pearly white, radiating. Brunner and Smith, 1883, 279–280.

	A	B	C	D	E
SiO_2	56.74	55.10	58.00	54.27	57.49
Al_2O_3	16.44	14.18	13.40	17.24	13.03
Fe_2O_3	——	——	tr.	——	——
CaO	8.29	9.40	7.80	7.81	8.06
MgO	——	——	1.40	——	tr.
Na_2O	0.14	2.70	tr.	1.81	1.36
K_2O	0.06	0.40	1.03	——	——
H_2O	18.90	18.60	18.30	19.56	19.42
	100.57	100.38	99.93	100.69	99.36
Sp. gr.		2.197		2.12	2.2

F.-G. Raudenbush mine, Berks County. Smith, Am. Chem. J., VI, 1885, 414; analysis by F. P. Davidson; H. Fegley's mine, Berks County. Hoskinson and Brunner, Am. Chem. J., VI, 414, 1885. White, radiating needles. I. Jacob Schell's farm, near Hosensack Station, Lehigh County. Radiations. Smith, Am. Chem. J., V, 227, 1883. J. Rockhill, Bucks County. Small yellowish-white crystals. Eyerman, 1911, 12. K.–L. York Haven, York County. K, white, pearly, radiating. L, altered. Ehrenfeld, 1890, 157; 1893, 4.

	F	G	H	I	J	K	L
SiO_2	58.01	58.15	57.54	55.31	54.83	47.20	52.07
Al_2O_3	13.75	12.47	12.67	14.88	16.94	19.01	22.11
CaO	7.76	9.82	7.85	9.00	8.61	16.72	12.17
MgO	1.38		1.72	——	——	——	——
Na_2O	tr.	tr.	tr.	1.66	1.26	——	——
K_2O	0.42	0.43	1.09	——	0.17	2.39	tr.
H_2O	18.46	18.60	18.97	18.47	17.63	15.25	13.57
	99.78	99.47	99.84	99.32	99.44	100.57	99.92
Sp. gr.				2.21	2.100	1.825	

LOCALITIES: *Berks County:* Antietam Reservoir, Birdsboro, Boyertown, Fritz Island, Fegley's mine (Maple Grove), Jacksonwald, Jones Mine, Raudenbush mine, Gickerville (colorless, white, and yellow, crystals, aggregates), and Wheatfield mines; *Bucks County:* Rock Hill; *Chester County:* French Creek mines, Knauertown, and Pierce's Paper Mill (Kennett); *Delaware County:* Avondale, Leiperville, Lenni, and Ward's quarry; *Lehigh County:* Hosensack Station; *Montgomery County:* Flat Rock tunnel, Perkiomenville, Sumneytown, and West Conshohocken; *Philadelphia:* Fairmount Park, Frankford (white, radiating), Germantown, Hoffman's quarry, south of Lafayette, O'Neill's quarry, Rittenhouse quarry, Shawmont, and Wingohocking Creek; *York County:* York Haven.

EPIDESMINE

$(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$ ORTHORHOMBIC

Colorless to yellow. Transparent to translucent. Luster: vitreous, *b* pearly. Form: druses of prismatic to tabular crystals, a combination of the three pinacoids: *a* (100), *b* (010) and *c* (001). Cleavage: *a* and *b*. Sp. gr. 2.16.

Composition: $(Ca,Na_2)Al_2Si_6O_{16}.6H_2O$, the same as stilbite.

LOCALITY: *Berks County:* Gickerville; *Montgomery County:* Perkiomenville.

HEULANDITE

$CaAl_2Si_4O_{16}.5H_2O$ MONOCLINIC

Color: white, gray, yellow, pale-brown, reddish. Streak: white. Transparent to subtranslucent. Luster: vitreous, of *b* quite pearly. Form: thick tabular crystals, often grouped in parallel position. H = 3.5–4. Brittle. Sp. gr. 2.18–2.22.

Crystallography: Monoclinic; $a:b:c = 0.4035:1:0.8585$; $\beta = 91° 25'$.

$p_0:q_0:r_0 = 2.1276:0.8582:1$; $\mu = 88° 35'$.

Common forms: *b* (010), *c* (001), *m* (110), *t* (201), *s* ($\bar{2}01$). Habit: tabular parallel to *b*, faces usually undulating, *b* often depressed. Cleavage: *b* perfect.

Analysis: Near Adamstown, Lancaster County. Knerr and Schoenfeld, Am. Chem. J., VI, 1885, 412. Crystals.

SiO_2	57.68
Al_2O_3	17.05
CaO	6.78
MgO	0.69
K_2O	1.13
Na_2O	tr.
H_2O	16.61
	99.94
Sp. gr.	2.2

LOCALITIES: *Berks County:* Jacksonwald, and Gickerville; *Bucks County:* Rockhill; *Chester County:* French Creek mines; *Delaware County:* Leiperville, and Ward's quarry; *Lancaster County:* Adamstown; *Montgomery County:* Flat Rock tunnel; and Perkiomenville; *Philadelphia:* Fairmount Park, Frankford, south of Lafayette, and Rittenhouse quarry.

CHABAZITE

$(Ca,Na_2)Al_2Si_4O_{12}.6H_2O$ RHOMBOHEDRAL

Colorless, white, flesh-red. Streak uncolored. Transparent to translucent. Luster: vitreous. Form: rhombohedral crystals, cubic in appearance, and commonly in penetration twins. H = 4–5. Brittle. Sp. gr. 2.08–2.16.

Crystallography: Rhombohedral; c = 1.0860; p_0 = 0.7240. Common forms: *r* ($10\bar{1}1$) striated, *e* ($01\bar{1}2$), *s* ($02\bar{2}1$). Commonly in penetration twins, twin axis *c*. Cleavage: *r* distinct, fracture uneven.

Composition: $(Ca,Na_2)Al_2Si_4O_{12}.6H_2O$; Al_2:Si varies from 1:3 to 1:5, H_2O increasing with SiO_2. With Ca:Na_2 = 1:1, SiO_2 47.2, Al_2O_3 20.0, CaO 5.5, Na_2O 6.1, H_2O 21.2, = 100.

Analyses: A. Clark's quarry, Frankford, Philadelphia. Yellowish-brown. Eyerman, 1911, 12. B. Lenni, Delaware County. Eyerman, 1911, 12. C. Railroad cut east of Reading (probably Birdsboro), Berks County. Smith, 1910, 539. Colorless or white crystals. D. Fritz Island, Berks County. Colorless, vitreous crystals, Sadtler, Jr., 1883, 356. E. York Haven, York County. Ehrenfeld, 1893, 4.

	A	B	C	D	E
SiO_2	49.69	48.61	48.59	50.28	50.69
Al_2O_3	18.21	16.15	18.49	17.83	19.46
Fe_2O_3	0.69	3.76	——	——	——
CaO	7.06	8.00	8.78	6.96	7.28
MgO	——	——	0.05	0.22	——
Na_2O	3.41	0.40	1.41	2.43	——
K_2O	0.84	0.29	0.69	2.40	1.38
H_2O	20.19	22.58	22.01	20.21	21.32
	100.09	99.79	100.02	100.33	100.13
Sp. gr.			2.053	2.3	2.18

LOCALITIES: *Berks County:* Birdsboro, Fritz Island (colorless), Gickerville, and Jacksonwald; *Chester County:* Cloud's farm and Pierce's Paper Mill (Kennett); *Delaware County:* Avondale (red), Henvi's quarry (red), Leiperville, Lenni (colorless, white, and red), Morgan Station, Trainer, and Waterville; *Montgomery County:* Flat Rock tunnel; and Perkiomenville; *Philadelphia:* Fairmount Park, Frankford, Hoffman's quarry, south of Lafayette, and Rittenhouse quarry; *York County:* York Haven.

LAUMONTITE

$CaAl_2Si_4O_{12}.4H_2O$ MONOCLINIC

Color: white, yellow, gray. Streak: uncolored. Transparent to translucent, becoming opaque and often pulverulent on exposure. Luster: vitreous, somewhat pearly on cleavage faces. Form: small prismatic crystals with acute terminations, in columnar, radiating groups. H = 3.5–4. Sp. gr. 2.25–2.36.

Crystallography: Monoclinic; a:b:c = 1.1451:1:1.1811; β = 111° 14′,
$p_0:q_0:r_0$ = 1.0314:1.1009:1; μ = 68° 46′.

Common forms: *m* (110), terminated by *e* ($\bar{2}01$); cleavage: *b* and *m* very perfect; *a* imperfect. Fracture: uneven.

Composition: $CaAl_2Si_4O_{12}.4H_2O$; SiO_2 51.1, Al_2O_3 21.7, CaO 11.9, H_2O 15.3, = 100. In the air laumontite loses one molecule of H_2O.

Analysis: Railroad cut east of Reading (probably Birdsboro), Berks County. Chalk-white, vitreous and pearly. Smith, 1910, 538.

SiO_2	52.12
Al_2O_3	22.20
CaO	11.89
Ignition	14.12
	100.33

LOCALITIES: *Berks County:* Birdsboro, and Gickerville; *Delaware County:* Lenni, and Ward's quarry; *Philadelphia:* Fairmount Park, south of Lafayette, and Rittenhouse quarry.

GISMONDITE

$(K_2,Ca)Al_2Si_3O_{10}.4H_2O$ MONOCLINIC

Colorless to white or gray. Transparent to translucent. Luster: vitreous. Form: pseudo-tetragonal octahedra (due to twinning), faces rough and formed of many individuals. H = 4.5. Sp. gr. 2.609.

Analyses: Fritz Island, Berks County. White, translucent, vitreous twinned crystals, with calcite. A. Genth, 1875, 110. "Undescribed zeolite." 9.75% calcite deducted, analysis recalculated. B. Eyerman, 1904, 48.

	A	B
SiO_2	43.36	39.53
Al_2O_3	28.78	26.38
CaO	10.95	14.89
Na_2O	0.68	0.87
K_2O	1.38	2.22
H_2O	15.52	16.59
	100.67	100.48
Sp. gr.		2.069

LOCALITY: *Berks County:* Fritz Island.

NATROLITE

$Na_2Al_2Si_3O_{10}.2H_2O$ ORTHORHOMBIC

Colorless, white, gray, yellow. Transparent to translucent. Luster: vitreous, somewhat pearly when fibrous. Form: radiating, fibrous; slender acicular prismatic crystals. H = 5–5.5. Sp. gr. 2.20–2.25.

Crystallography: Orthorhombic; a:b:c = 0.9811:1:0.3523.
$p_0:q_0:r_0$ = 0.3591:0.3525:1

Common forms: *m* (110) terminated by *o* (111). Habit: prismatic, pseudo-tetragonal. Cleavage: *m* perfect, *b* imperfect

Composition: $Na_2Al_2Si_3O_{10}.2H_2O$; SiO_2 47.4, Al_2O_3 26.8, Na_2O 16.3, H_2O 9.5, = 100.
Analysis: Lenni, Delaware County. Crystals. Eyerman, 1911, 11.

SiO_2	45.92
Al_2O_3	28.15
Fe_2O_3	0.44
CaO	2.48
Na_2O	12.28
H_2O below 115°	0.34
H_2O above 115°	10.90
	100.51
Sp. gr.	2.320

LOCALITIES: *Berks County:* Birdsboro, and Gickerville; *Delaware County:* Leiperville, Lenni (druses of colorless crystals), Felton's farm (Chester), and Ward's quarry; *Montgomery County:* Sumneytown, and Perkiomenville; *Philadelphia:* Fairmount Park, Frankford, and Ritenhouse quarry.

SCOLECITE

$CaAl_2Si_3O_{10}.3H_2O$ MONOCLINIC

Colorless, white. Transparent to subtranslucent. Luster: vitreous, silky when fibrous. Form: radiating, fibrous. H = 5–5.5. Sp. gr. 2.16–2.4.
Composition: $CaAl_2Si_3O_{10}.3H_2O$; SiO_2 45.9, Al_2O_3 26.0, CaO 14.3, H_2O 13.8, = 100.
Analysis: Railroad cut east of Reading (probably Birdsboro), Berks County. White, silky mass of radiating needles, with calcite. Smith, 1910, 540.

SiO_2	47.04
Al_2O_3	25.42
CaO	9.86
Na_2O	4.77
Ignition	13.60
	100.69
Sp. gr.	2.277

LOCALITY: *Berks County:* Birdsboro.

MESOLITE

$\left\{ \begin{array}{l} m\ Na_2Al_2Si_3O_{10}.2H_2O \\ n\ CaAl_2Si_3O_{10}.3H_2O \end{array} \right.$ MONOCLINIC

Colorless, white, grayish, yellowish. Transparent to translucent; opaque when amorphous. Luster: vitreous, silky when fibrous. Form: fibrous, interlacing, columnar; divergent groups or tufts; cryptocrystalline. H = 5. Sp. gr. 2.2–2.4.
Composition: Intermediate in composition between natrolite and scolecite. With Na_2: Ca = 1:2, SiO_2 46.4, Al_2O_3 26.3, CaO 9.6, Na_2O 5.3, H_2O 12.4, = 100.
Analysis: Fritz Island, Berks County. Sadtler, Jr., Am. Chem. J., IV, 356, 1883.

SiO_2	43.29
Al_2O_3	25.02
Fe_2O_3	tr.
CaO	12.15
Na_2O	3.40
H_2O	16.01
	99.87
Sp. gr.	2.4

LOCALITIES: *Berks County:* Fritz Island, minute white radiating tufts; *Delaware County:* Ward's quarry, mealy white radiations.

THOMSONITE

$(Ca,Na_2)Al_2Si_2O_8.2\frac{1}{2}H_2O$ ORTHORHOMBIC

Colorless, white, green, reddish. Streak: uncolored. Transparent to translucent. Luster: vitreous, more or less pearly. Form: columnar, fibrous; radiated spherical concretions; rarely in druses of prismatic crystals. H = 5–5.5. Brittle. Sp. gr. 2.3–2.4.

Crystallography: Orthorhombic; a:b:c = 0.9932:1:1.0066.

$p_0:q_0:r_0 = 1.0135:1.0066:1.$

Forms: *c* (001), *a* (100), *b* (010), *m* (110), *r* (101). Habit: prismatic, prism faces striated vertically. Cleavage: *b* perfect, *a* less so, *c* in traces.

Composition: $(Ca,Na_2)Al_2Si_2O_8.2\frac{1}{2}H_2O$; with $Ca:Na_2$ = 3:1, SiO_2 37.0, Al_2O_3 31.4, CaO 12.9, Na_2O 4.8, H_2O 13.9, = 100.

Analysis: Fritz Island, Berks County. White, waxy to pearly luster, spherical aggregations of radiating structure. Genth, 1875, 108.

SiO_2	38.74
Al_2O_3	(31.22)
CaO	10.77
Na_2O	3.32
K_2O	0.45
H_2O	15.50
	100.00

LOCALITIES: *Berks County:* Birdsboro, and Fritz Island (small spherical aggregations of radiated structure); *Delaware County:* Leiperville, and Lenni (druses of minute colorless crystals, with natrolite).

ANALCITE

$NaAlSi_2O_6.H_2O$ ISOMETRIC

Color: white, grayish, yellowish; colorless. Transparent to nearly opaque. Luster: vitreous. Form: in trapezohedrons, *n* (211); massive granular. H = 5–5.5. Brittle. Sp. gr. 2.22–2.29.

Composition: $NaAlSi_2O_6.H_2O$; SiO_2 54.5, Al_2O_3 23.2, Na_2O 14.1, H_2O 8.2, = 100.

LOCALITIES: *Bucks County:* Rushland; *Lebanon County:* Cornwall? *Philadelphia:* Fairmount Park.

MICA GROUP

MUSCOVITE	$H_2KAl_3(SiO_4)_3$	Monoclinic
EUPHYLLITE	$H_2(Na,K)Al_3(SiO_4)_3$?	Monoclinic
BIOTITE	$(H,K)_2(Mg,Fe)_2(Al,Fe)_2(SiO_4)_3$	Monoclinic
PHLOGOPITE	$[H,K(MgF)]_2Mg_2Al(SiO_4)_3$	Monoclinic

MUSCOVITE

$H_2KAl_3(SiO_4)_3$ MONOCLINIC

Colorless, gray, brown, pale green, or yellow. Transparent to translucent. Luster: vitreous to pearly or silky. Form: pseudo-orthorhombic or pseudo-hexagonal tabular crystals; foliated, plumose, scaly, massive, compact, cryptocrystalline. H = 2–2.5. Sp. gr. 2.76–2.78.

Crystallography: Monoclinic:[48] a:b:c = 0.5774:1:3.3128, $\beta = 89° 54'$. Common forms: M (221), *b* (010), *c* (001), and *e* (023). Twins: twin plane in zone *c*M normal to c. Cleavage: basal, eminent; secondary parallel to *b*; thin laminae flexible and elastic.

Composition: $H_2KAl_3(SiO_4)_3$; with H:K = 2:1, SiO_2 45.2, Al_2O_3 38.5, K_2O 11.8, H_2O 4.5, = 100.

DAMOURITE. Color: white, gray, yellow, reddish. Luster: somewhat pearly or silky. Feel unctuous. Form: small scales, fibrous or compact cryptocrystalline. Folia are less elastic than muscovite. Fibrous forms are known as sericite. Fuchsite: green; contains Cr. Lesleyite (Lea, 1867, 44) is a mixture of damourite and corundum from Unionville.

[48] Orthorhombic according to Goldschmidt:
a:b:c = 0.5773:1:3.293
$p_0:q_0:r_0$ = 5.704:3.293:1

Optic Axial Angles

Muscovite

Philadelphia	greenish-gray, banded	60°–61°	Silliman[49]
Fairmount Park	smoky brown	62°	Silliman
Germantown	smoky brown crystals	63°	Lewis[50]
Germantown		64°	Lewis
Germantown	crystals in biotite	64°	Lewis
Germantown	large silvery plates	67°	Lewis
Falls of Schuylkill	in hornblende gneiss	65°	Lewis
Frankford	in hornblende gneiss	65°	Lewis
Darby	small scales in gneiss	61°	Lewis
Upland	pale green	70°	Lewis
Leiperville	faint greenish, plicated	70°–71°	Silliman
Morgan Station		60°	Lewis
Poorhouse quarry		64°	Lewis
Pennsbury	smoky brown	57°	Lewis
Pennsbury	smoky brown, striated	59°	Silliman
Pennsbury	brown crystals	69°–70°	Silliman
Pennsbury	brownish-green	70°	Silliman
Unionville	white	67°–70°	Silliman
Chester County		70°	Lewis

Damourite

Unionville		69°–76°	Lewis

Analyses

Muscovite

A. Easton, Northampton County. Large crystals. Eyerman, 1911, 13. B–C. Swayne's farm, Pennsbury, Chester County. Eyerman, 1911, 13.

	A	B	C
SiO_2	44.52	43.80	45.18
Al_2O_3	34.02	32.45	33.41
Fe_2O_3	2.51	5.74	3.05
FeO	1.14	1.04	1.07
CaO	0.13	tr.	——
Na_2O	3.01	2.00	3.00
K_2O	9.47	9.79	10.50
F	tr.	——	tr.
H_2O	4.72	4.93	4.22
	99.52	99.75	100.43
Sp. gr.	2.879	2.890	2.874

Damourite

A. Poorhouse quarry, West Bradford, Chester County. Minute tuft-like aggregates on dolomite. Smith and Brush, 1853, 47. B. 2½ miles south of Blandon, Berks County. Pale green, massive, lamellar. Genth, Jr., 1882, 48. C. Rockland Forges, Berks County. Partial analysis by Genth, Jr., 1882, 48.

	A	B	C
SiO_2	45.50	49.60	
Al_2O_3	34.55	32.11	
Fe_2O_3	tr.	2.94	
CaO	2.31	——	
MgO	1.08	tr.	
Na_2O	2.35	0.36	0.36
K_2O	8.10	9.53	10.32
H_2O, CO_2	5.40	4.86	5.60
	99.29	99.40	

[49] Silliman, Jr., 1850, 372.

[50] H. Carvill Lewis, 1880, 245–249.

D–M. Unionville, Chester County. D. Granular; Dana, 1850, 357; analysis by Darrach. K_2O too low. E. White and greenish-white crystals. Mean of several analyses, Sharples, 1869, 319. F. White and greenish-white crystals. Genth, 1873, 386; analysis by Koenig. G. White, scaly, radiating, pseudomorphous after corundum; Genth, 1873, 386. H. Silver-gray scales, pseudomorphous after corundum. Genth, 1873, 386.

	D	E	F	G	H
SiO_2	46.75	43.56	43.03	45.86	45.57
Al_2O_3	39.20	38.16	39.06	37.65	34.83
Fe_2O_3	tr.	——	1.48	0.59	2.94
MgO	1.02	——	0.30	0.55	0.83
CaO	0.39	——	tr.	0.31	0.40
Li_2O	——	——	tr.	tr.	tr.
Na_2O	——	——	0.58	0.80	0.87
K_2O	6.56	10.81	10.05	10.40	10.16
H_2O	4.90	5.64	5.40	4.74	5.30
	98.82	98.17	99.90	100.90	100.90
Sp. gr.		2.87	2.851		2.843

I. Greenish-white, pearly, massive. Genth, 1873, 386, analysis by Koenig. J. White, fibrous, pseudomorphous after corundum. Genth, 1873, 386, analysis by Koenig. K. Yellowish-green, cryptocrystalline, pseudomorphous after corundum, Genth, 1873, 386. L. Yellowish-green, cryptocrystalline, waxy, pseudomorphous after corundum. Genth, 1873, 386, analysis by Chatard. M. "Lesleyite," a mixture of damourite and corundum. Unionville, Chester County. White. Genth, 1873, 388. For other analyses of this mixture see Leeds, 1873, 25; Genth, 1873, 388; Sharples, 1869, 319; and Smith, 1869, 255.

	I	J	K	L	M
SiO_2	45.73	45.73	46.98	46.60	32.32
Al_2O_3	37.10	36.30	35.13	32.39	56.43
Fe_2O_3	1.30	0.83	0.61	2.54	0.29
MgO	0.34	0.54	1.32	2.01	0.38
CaO	tr.	0.74	0.13	tr.	0.32
Li_2O	tr.	tr.	tr.	tr.	tr.
Na_2O	0.88	0.58	0.76	0.54	0.32
K_2O	10.50	10.49	10.74	10.39	7.31
H_2O	4.48	5.17	4.77	4.81	4.01
	100.33	100.38	100.44	99.28	101.38
Sp. gr.	2.857	2.832	2.779	2.760	

LOCALITIES: *Berks County:* Antietam Reservoir, Clymer mine, and Huff Church; *Bucks County:* Finney's quarry, Hulmeville, Newportville, and Vanartsdalen's quarry; *Chester County:* Avondale, Bailey's quarry (West Marlboro), Beryl Hill, Sylmar, Brinton's farm (Thornbury), Brinton's quarry (Westtown), Chester Springs, Copesville, Corundum Hill (Newlin), Embreeville, Johnson and Patterson's quarry (Newlin), Lewisville, Nevin's quarry, New London (large sheets, enclosing magnetite), Oxford, Pennsbury (farms of Swayne, Dilworth, Craig, and Marshall; crystals up to 30 × 45 cm. and weighing 100 pounds; often enclosing quartz, magnetite, and hematite); south of Phillip's quarries, Pugh's farm (East Nottingham), and Pusey's quarries; *Delaware County:* Avondale, Black Horse, Boothwyn, Brandywine Summit, Bunting's quarry, Chelsea, Custer's farm (Darby), Darby, Evan's farm (Middletown), Franklin Paper Mills, Gillespie's quarry, Hunter's farm (Upper Providence), Irving's quarry, Kellyville, Knowlton, Lansdowne, Leiperville, Morgan, Morton, Peter's Mill dam (Aston), Sharpless' quarry near Glen Mills (crystals measuring 25 cm. with inclusions of quartz, magnetite, and gahnite), Sharpless' farm (Nether Providence), Shaw and Esrey's quarry in Chester (yellow and greenish crystals), Smedley's quarry near Lima, Strath Haven Inn, Sycamore Mills, Upper Darby, and Ward's quarry; *Lancaster County:* Cocalico; *Montgomery County:* Flat Rock tunnel, King of Prussia, and Wyncote; *Northampton County:* Chestnut Hill, and Lehigh Mountain; *Philadelphia:*

Branchtown, Bustleton, Cheltenham, Chestnut Hill, Cobb's Creek, Fairmount Park, Falls of Schuylkill, Fox Chase, Frankford, Germantown, Holmesburg, Logan (greenish crystals measuring 15 cm.), Manayunk, Overbrook, Rittenhouse quarry, Ryers, Tabor, Tacony Creek, West Philadelphia, Wingohocking Creek, and Wissahickon Valley.

Fuchsite: *Chester County:* Young's farm (West Bradford).

Damourite: *Berks County:* Blandon, Green Hill, and Merkle's farm (Oley); *Chester County:* Corundum Hill (Newlin, lesleyite); Poorhouse quarry (West Bradford); *Delaware County:* Moore, and Ridleyville.

Falunite

Color: grayish-green, greenish-brown, to dark green; streak: colorless. Luster: pearly or waxy on cleavage surfaces. Translucent. Form: cleavage masses, with a basal cleavage. H = 3.5–5. Sp. gr. 2.6–2.8.

Composition: a hydrous silicate of Al, Fe, and Mg; an alteration product of iolite.

Localities: *Philadelphia:* Rittenhouse quarry? Wayne quarries? (Germantown), and Wissahickon Valley?

EUPHYLLITE

$H_2(Na,K)Al_3(SiO_4)_3$? Monoclinic

Colorless, white, grayish, greenish. Transparent to translucent; nearly opaque. Luster: of cleavage surfaces pearly, bright. Form: aggregated laminae, scales, compact masses. Laminae separable but rather brittle. $2E = 71°30'$, (Silliman)[51], 36°–37°, (Lewis).[52] H = 3.5–4.5. Sp. gr. 2.93–3.008.

Analyses: Unionville, Chester County. White, micaceous, with corundum in albite. A.–D. Smith and Brush, 1853, 209. E.–F. Genth, 1875, 127, analyses by Koenig.

	A	B	C	D	E	F
SiO_2	40.29	39.64	40.21	40.96	41.45	41.46
Al_2O_3	43.00	42.40	41.50	41.40	42.30	42.19
FeO	1.30	1.60	1.50	1.30	——	——
MgO	0.62	0.70	0.78	0.70	——	——
CaO	1.01	1.00	1.88	1.11	——	——
Na_2O	5.16	5.16	4.26	4.26	(7.32)	(7.45)
K_2O	3.94	3.94	3.25	3.25		
H_2O	5.00	5.08	5.91	6.23	6.66	8.90
Corundum	——	——	——	——	(2.27)	——
	100.32	99.52	99.29	99.21	100.00	100.00

Earlier analyses by Crooke: Silliman, Jr., 1849, 382; Erni, Garrett, and Sharples: Dana, 1850, 362; have been shown to be erroneous (Smith and Brush, 1853, 209).

Locality: *Chester County:* Corundum Hill (Newlin).

BIOTITE

$(H,K)_2(Mg,Fe)_3(Al,Fe)_2(SiO_4)_3$ Monoclinic

Color: green to black, in very thin laminae brownish. Streak: uncolored. Transparent to opaque. Luster: splendent, more or less pearly on cleavage faces; submetallic; lateral faces vitreous. Form: disseminated scales, massive aggregations of cleavable scales; pseudo-rhombohedral crystals. Cleavage: basal, highly perfect; parting parallel to *b*, and μ $(\bar{1}11)$. H = 2.5–3. Sp. gr. 2.7–3.1.

[51] Silliman, Jr., 1849, 381; the mineral may be a mixture of paragonite and margarite (Tschermak, Min., 1885, 514; Zeit. Kryst., 2, 46, 1878; 3, 166, 1879)

[52] Lewis, 1880, 249.

Varieties: Lepidomelane: black; opaque, translucent in very thin laminae. Luster adamantine inclining to vitreous; pearly. Form: lamellar masses, aggregates of minute scales or six-sided tables. H = 3. Sp. gr. 3.0–3.2. Cleavage: basal, eminent; somewhat brittle. The mineral contains a high percentage of Fe_2O_3.

PHILADELPHITE:[53] An altered biotite from Wayne Junction, Philadelphia. Color: brownish-red; opaque; luster pearly. Form: contorted and wrinkled plates with micaceous structure; laminae flexible, inelastic; tough. Feel: greasy. H = 1–3. Sp. gr. 2.80. Optically biaxial; double refraction strong, –. 2E = 31°–39°.

A number of altered biotites are described under the vermiculites.

OPTIC AXIAL ANGLES

Darby	Deep red	0°	Lewis[54]
Delaware County	Crystal in muscovite	5°	Lewis
Easton	Silver-white	2°	Lewis
Easton	Silver-white	1°–2°	Grailich[55]
Frankford	Lepidomelane	0°	Lewis
Wayne Junction	Philadelphite	31°–39°	Lewis

Analyses: A–B. Forty-fourth Street and Baltimore Avenue, Philadelphia. Brownish-black. A. Genth. B. Genth Jr. Second Geol. Surv. Penna., C6, 1881, 121. C. "Lepidomelane." Clark's quarry, Frankford, Philadelphia. Black plates. Eyerman, 1911, 14. D–E. "Philadelphite," altered biotite. Wayne Junction, Philadelphia. Brown plates, seams in hornblende gneiss. H. Carvill Lewis, 1880, 313; D. Haines, E. Lewis. Each an average of two analyses. F. Easton, Northampton County. Knop, 1887, 603–604.

	A	B	C	D	E	F
SiO_2	36.02	36.19	40.95	38.79	35.73	34.82
TiO_2	2.20	1.68	4.98	——	1.03	2.00
Al_2O_3	18.95	21.66	17.44	14.78	15.77	16.91
Fe_2O_3	3.17	2.64	1.38	20.30	19.46	4.19
V_2O_3	——	——	——	——	0.37	——
FeO	16.44	16.96	18.48	2.04	2.18	15.96
MnO	0.67	0.52	tr.	——	0.50	——
NiO, CoO	——	——	——	——	0.06	——
CuO	0.10	tr.	——	——	0.08	——
MgO	9.39	9.36	3.61	11.40	11.56	13.98
CaO	——	——	——	1.03	1.46	——
Li_2O	tr.	tr.	——	——	tr.	——
Na_2O	0.29	0.45	2.60	0.77	0.90	2.49
K_2O	9.25	8.51	6.78	6.75	6.81	7.48
P_2O_5	——	——	——	——	0.11	——
H_2SO_4	——	——	——	——	tr.	——
Cl	——	——	——	——	tr.	——
F	n. det.	n. det.	——	——	——	——
H_2O	2.97	2.07	3.05	4.27	4.34	1.79
	99.45	100.04	99.27	100.13	100.36	99.62
Sp. gr. (in alcohol)				2.78 – 2.96		

G–L. Easton, Northampton County. G. Rammelsberg, 1866, 809. H. Silver-white. The old "Water Lot," Easton. Eyerman, 1911, 13–14. I. Darker, Easton. Eyerman, 1911, 13–14. J. Light brown. West Chestnut Hill, Easton, Eyerman, 1911, 13–14. K. Brown. "Syenite Ridge," Easton. Eyerman, 1911, 13–14. An altered biotite has been named Eastonite, and is described below under the vermiculites.

[53] Lewis, 1880, 313–328.
[54] Lewis, 1880, 246–247.
[55] Grailich, 1853, 46.

	G	H	I	J	K
SiO_2	46.74	41.07	40.32	41.12	40.11
Al_2O_3	35.10	23.34	17.60	17.23	18.03
Fe_2O_3	1.53	4.35	4.30	3.14	5.80
FeO	4.00	——	15.01	——	——
CaO	——	——	——	0.89	0.46
MgO	0.80	23.00	14.40	24.00	24.79
Na_2O	tr.	1.60	——	0.42	tr.
K_2O	9.63	6.30	——	9.50	10.50
F	1.05	tr.	——	tr.	——
H_2O	3.36	0.26	——	3.56	0.25
	102.21	99.92		99.86	99.94
Sp. gr.	2.904	2.712			2.881

LOCALITIES: *Berks County:* Huff Church; *Bucks County:* Finney's quarry, Morrisville, Newportville, and Paxon's quarry; *Chester County:* Johnson and Patterson's quarry, and Marshall's farm (Pennsbury); *Delaware County:* Adele, Avondale, Boothwyn, Brandywine Summit, Chester, Darby, Elam, Gillespie's quarry, Leiperville, Morton, and Ward's quarry; *Lancaster County:* Gap mines; *Montgomery County:* Lafayette, and Paper Mills Station; *Northampton County:* Chestnut Hill (silver-white, green, and brown); *Philadelphia:* Fairmount Park, Falls of Schuylkill, Fox Chase, Frankford, Germantown (philadelphite), Holmesburg, Logan, Overbrook, O'Neill's quarry, Rittenhouse quarry (philadelphite), West Philadelphia, and Wingohocking Creek.

PHLOGOPITE

$[H,K(MgF)]_2Mg_2Al(SiO_4)_3$ MONOCLINIC

Color: yellowish-brown, brownish-red. Transparent to translucent. Luster: pearly; submetallic. Form: disseminated scales, lamellar masses; pseudo-rhombohedral crystals. Cleavage: basal, highly perfect; thin laminae, tough and elastic. H = 2.5–3. Sp. gr. 2.78–2.85.

OPTIC AXIAL ANGLES

Kennett Square	brown, in limestone	15°	Lewis[46]
Vanartsdalen's	reddish-brown	34°	Lewis

Analysis: "Pennsbury, Chester County?" Brown. Neminarz, Min. Mitth., (1) 241–242, 1874.

SiO_2	44.29
Al_2O_3	12.12
Fe_2O_3	1.40
FeO	1.44
MgO	27.86
Li_2O	tr.
Na_2O	2.16
K_2O	7.06
F	1.94
H_2O	2.09
	100.36
Sp. gr.	2.779

LOCALITIES: *Bucks County:* Vanartsdalen's quarry; *Chester County:* Cope's quarry, Kennett Square, Nevin's quarry, and Poorhouse quarry; *Northampton County:* Chestnut Hill.

MARGARITE GROUP

MARGARITE	$H_2CaAl_4Si_2O_{12}$	Monoclinic
CHLORITOID	$H_2(Fe,Mg)Al_2SiO_7$	Monoclinic?

[46] Lewis, 1880. 245–246.

MARGARITE

$H_2CaAlSi_2O_{12}$ MONOCLINIC

Color: grayish, reddish-white, pink, yellow. Translucent to subtranslucent. Luster: pearly; lateral faces vitreous. Form: foliated masses, aggregates of laminae; massive scaly. Cleavage: basal, perfect. Laminae rather brittle. H = 3.5–4.5. Sp. gr. 2.99–3.08.

Composition: $H_2CaAlSi_2O_{12}$; SiO_2 30.2, Al_2O_3 51.3, CaO 14.0, H_2O 4.5, = 100.

Synonyms: corundellite,[57] emerylite.[58]

Analyses: A–D. "Village Green," Aston Township, Delaware County. Pearly scales with a nucleus of bronze-brown corundum. Silliman, Jr., 1849, 379, analyses by W. J. Craw. E. Unionville, Chester County. Altered from corundum. Genth, 1882, 390. F. Unionville, Chester County. "Corundellite." Silliman, Jr., 1849, 380, analysis by J. J. Crooke.

	A	B	C	D	E	F
SiO_2	32.31	31.06	31.26	30.18	34.10	35.71
Al_2O_3	49.24	51.20	51.60	51.40	47.38	53.13
Fe_2O_3	——	——	——	——	0.34	——
MgO	0.30	0.28	0.50	0.72	0.17	——
CaO	10.67	9.24	10.15	10.87	9.20	7.27
Li_2O	——	——	——	——	tr.	——
Na_2O	2.22	2.97	1.22	2.77	1.14	0.41
K_2O					2.34	1.22
H_2O, F	5.26	5.25	5.27	4.52	4.43	2.30
Corundum	——	——	——	——	0.54	——
	100.00	100.00	100.00	100.46	99.64	100.04
Sp. gr.	2.995				2.997	

G–H. Unionville, Chester County. G. Cryptocrystalline, frequently coating corundum, Genth, 1873, 402. H. White, massive, or granular. Genth, 1873, 402. I. White, faintly pinkish, laminated; occurs rarely with granular corundum and tourmaline. Genth, 1873, 402, J. White, faintly reddish, scaly, somewhat laminated aggregates with black tourmaline. Genth 1873, 402; analysis by Koenig. K. Grayish to brownish-white, waxy, cryptocrystalline, with particles of unaltered corundum. Genth, 1873, 402, analysis by Chatard. L. Dana, 1850, 362, analysis by Craw. M. Dana, 1850, 362, analysis by C. Hartshorne.

	G	H	I	J	K	L	M
SiO_2	32.19	30.45	30.70	31.48	31.29	29.99	32.15
Al_2O_3	49.62	50.86	49.33	49.01	47.24	50.57	54.28
FeO	0.91	0.42	0.39	0.52	0.85	——	tr.
MgO	0.41	0.37	0.76	0.54	0.88	0.62	0.05
CaO	7.81	12.13	11.86	10.70	10.86	11.31	11.36
Li_2O	tr.	tr.	0.36		tr.	——	n. det.
Na_2O	4.78	1.72	0.96	1.34	2.66	1.62	n. det.
K_2O	0.57	0.25	0.65		0.24	0.85	n. det.
H_2O	3.93	4.48	5.91	3.94	5.92	5.14	0.50
Corundum	——	tr.	——	2.00	——	——	——
	100.22	100.68	100.92	99.53	99.94	100.10	98.34
Sp. gr.	3.012	3.047			3.00		

LOCALITIES: *Chester County:* Corundum Hill (Newlin), yellowish-white or pinkish, broad foliated masses, fibrous, scaly or cryptocrystalline aggregates. *Delaware County:* Morgan Station, yellowish-white, pearly scales, forming a sheathing over corundum crystals.

CHLORITOID

$H_2(Fe,Mg)Al_2SiO_7$ MONOCLINIC?

Color: dark gray, greenish-gray, or black. Streak: uncolored, grayish or slightly greenish.

[57] Silliman, 1849, 380.

[58] Silliman, 1849, 378; Smith and Brush, 1853, 207.

Luster: of cleavage surfaces pearly. Form: disseminated scales or plates; foliated masses. Cleavage: basal, laminae brittle. Sp. gr. 6.5. Sp. gr. 3.52–3.57.

Analysis: Whitestown, Adams County. Dark greenish-black scales in a chloritic (?) schist. Genth, 1876, 227. Recalculated for the pure mineral after deducting 5.91% SiO_2 probably present as quartz, and 1.92% TiO_2, most likely present as rutile.

SiO_2	28.19
Al_2O_3	37.67
Fe_2O_3	3.12
FeO	22.21
MnO	tr.
MgO	2.28
H_2O	6.53
	100.00
Sp. gr.	3.197

LOCALITIES: *Adams County:* Center Mills ore bank, Whitestown; *Chester County:* Corundum Hill? (Newlin); *Lancaster County:* Pequa mines (phyllite); *Montgomery County:* Conshohocken (phyllite).

CHLORITES

CLINOCHLORE	$H_8(Mg,Fe)_5Al_2Si_3O_{18}$	Monoclinic
PENNINITE	$H_8(Mg,Fe)_5Al_2Si_3O_{18}$	Rhombohedral
PROCHLORITE		
THURINGITE		
STILPNOMELANE (Chalcodite)		

CHLORITIC VERMICULITES

PAINTERITE
HALLITE
LENNILITE
PATTERSONITE
ROSEITE
LEIDYITE
EASTONITE

VERMICULITES

JEFFERISITE

CLINOCHLORE

$H_8(Mg,Fe)_5Al_2Si_3O_{18}$ MONOCLINIC

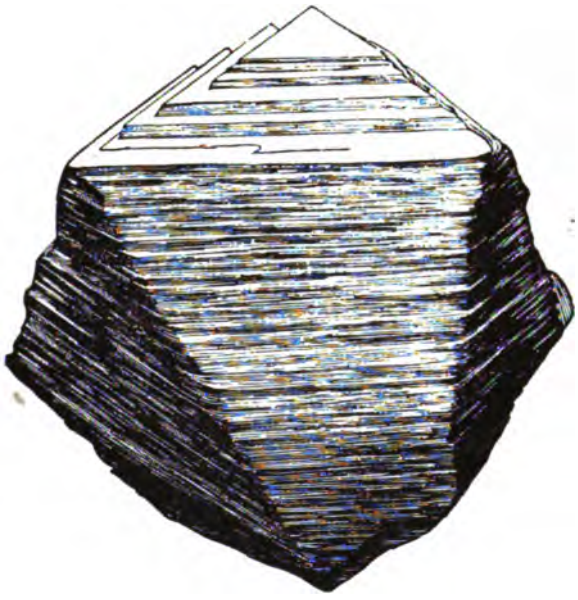
Color: dark grass-green to olive-green, pale green, yellow, white, rose-red. Streak: greenish-white; uncolored. Transparent to translucent. Luster: of cleavage surfaces somewhat pearly. Form: pseudo-hexagonal crystals of tabular habit, often tapering; rosette, fan-shaped, or vermicular aggregates; massive, scaly or granular. H = 2–2.5. Sp. gr. 2.65–2.78.

Crystallography: Monoclinic; $a:b:c = 0.5773:1:2.2772$; $\beta = 90° 20'$

$p_0:q_0:r_0 = 3.9427:2.2772:1$; $\mu = 89° 40'$.

Forms: *c* (001), *k* (011), *v* (132), *e* (6.6.17), *l* ($\bar{7}$.7.20), *x* (4.0.11), Brinton's quarry, Chester County.[59] Koksharov[60] lists the following forms from Wood's mine, Lancaster County: *c* (001), *i* ($\bar{1}$01), *g* ($\bar{4}$.0.13), *y* ($\bar{2}$05), m_0 (112), *β* ($\bar{8}$07), *b* (010), and A ($\bar{2}$.0.11). Habit: pseudo-hexagonal, often tabular parallel to *c*, also prismatic, triangular, and pseudo-rhombohedral. Pyramidal faces are often striated horizontally and repeated in oscillatory combinations. Twins are common; *Mica law:* twin-plane ⊥ *c* in the zone cm_0, sometimes as contact twins with the composition face *c*, one part being revolved 60° with reference to the other; in trillings of 3 or 6 sectors;[61] *Penninite law:* twin-plane *c*, contact twins with the composition face *c*, corresponding

[59] Tschermak, 1891, 221 and 249.
[60] Koksharov, 1888, 26–35.
[61] Cooke, 1867, 203–205.



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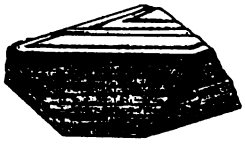

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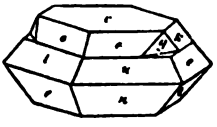

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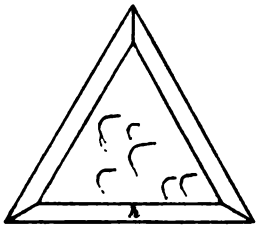

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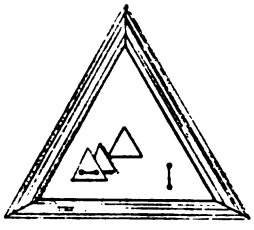

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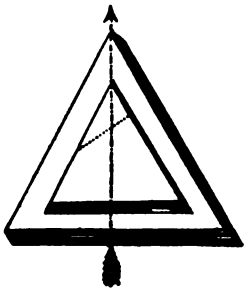

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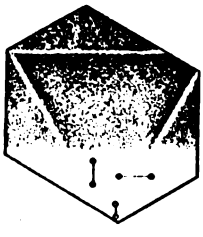

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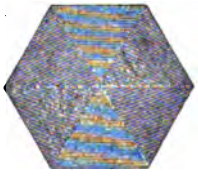
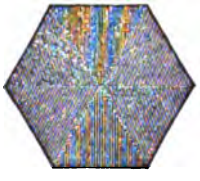


Texas.

72



Westchester.

73

Figs. 65–73. Clinochlore; 65–66, 68–69, 70–73, West Chester; 67, 71–73, Texas; (65, *Dana;* 66–69, 71, *Tschermak;* 70, *Blake;* 72–73, *Cooke*).

faces differing by 180°. Cleavage: *c* highly perfect; laminae flexible, tough, slightly elastic.

Optical properties: optically +, axial plane || *b*, rarely ⊥b. Dispersion $\rho < \nu$. Indices[62] $\alpha = 1.585$, $\beta = 1.588$, $\gamma = 1.596$. 2E = 20°–60°, Lancaster County;[63] 2E = 89° 41″, Brinton's quarry,[64] with Zc = 7° 10′. Pleochroism not strong, for green varieties, Lancaster County:[65]

X	Z
Emerald-green	Hyacinth-red
Leek-green	Yellowish-green

Composition: $H_8Mg_5Al_2Si_6O_{18}$; SiO_2 32.5, Al_2O_3 18.4, MgO 36.1, H_2O 13.0, = 100. FeO replaces a small part of MgO, and sometimes Cr replaces Al.

Synonyms: ripidolite, kotschubeite; some kammererite (see under penninite) belongs here.

Analyses: Brinton's quarry, Westtown, Chester County. Dark green crystals, and foliated masses. A. Clarke and Schneider, 1890, 406. B. Schlaepfer, 1891, 8. C. Neminarz, Min. Mitth., 1874, 177. D–E. Craw, 1852, 222–223.

	A	B	C	D	E
SiO_2	29.87	30.11	31.08	31.34	31.78
Al_2O_3	14.48	18.31	18.85	17.47	
Cr_2O_3	1.56	1.55	1.09	1.69	22.71
Fe_2O_3	5.52	1.16	1.55	3.85	
FeO	1.93	2.11	2.33	——	——
NiO	0.17	——	——	——	——
MgO	33.06	31.89	33.50	33.44	33.64
CaO	——	——	0.81	——	——
K_2O	——	0.37	——	——	——
Na_2O	——	1.99	——	——	——
Li_2O	——	0.31	——	——	——
H_2O	13.60	14.14	11.53	12.60	12.60
	100.19	101.94	100.74	100.39	100.73
Sp. gr.	2.4165				

Treated with dry HCl at 383°–412° for 19 hours: (Clarke and Schneider, 1890, 406.)

MgO removed	13.46
R_2O_3 removed	4.24
SiO_2 removed	0.92

LOCALITIES: *Berks County:* Jones mine? *Chester County:* Black Horse, and Brinton's quarry (large crystals in talc); *Delaware County:* Blue Hill, and Village Green; *Lancaster County:* Low's mine, and Wood's chrome mine; *Lebanon County:* Cornwall?

PENNINITE

$H_8(Mg,Fe)_5Al_2Si_6O_{18}$ RHOMBOHEDRAL

Color: green, emerald-green, apple-green, grayish-green; pink, rose-red, reddish-violet. Transparent to subtranslucent. Luster: of cleavage surfaces pearly, of lateral faces vitreous. Form: rhombohedral crystals, commonly twinned, habit thick tabular, often tapering; massive, scaly, cryptocrystalline. H = 2–2.5. Sp. gr. 2.6–2.85.

Crystallography: Rhombohedral, hemihedral; $a:c_1 = 1:3.495$; $p_0 = 2.330$. Forms: *c* (0001), *r* ($11\bar{2}1$), ϕ ($4.0.\bar{4}.13$), *y* ($20\bar{2}5$), *s* ($10\bar{1}3$), *x* ($11\bar{2}2$), ρ ($11\bar{2}4$); also ($11\bar{2}6$), ($22\bar{4}5$), ($9.\text{-}\bar{1}\bar{8}.20$), and ($7.7.\bar{1}\bar{4}.8$); (Lancaster County).[66] Twins according to the *Penninite Law*, twin-plane *c*, contact twins with the composition face *c*, corresponding faces differing by 180°. Cleavage: *c* highly perfect, laminae flexible.

[62] A. Michel-Levy and Alfred Lacroix, Les Minéraux des Roches, 1888.

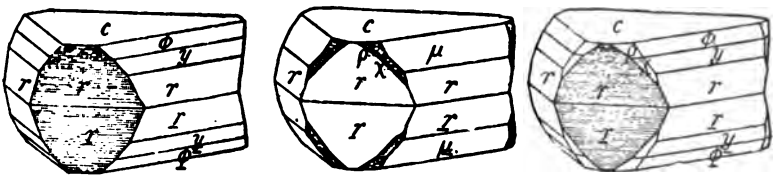
[63] Tschermak, 1891, 29–207.

[64] Tschermak, l. c.; Lewis (1880, 251) gives 78° 30′ and 82° for this locality; green plates from Patterson's quarry, Newlin, gave 59° 30′.

[65] Tschermak, l. c.

[66] Cooke, 1867, 201–203; Pirsson, 1891, 408.

Optical properties: optically + (Lancaster County), usually uniaxial. Strongly dichroic, ω violet, ϵ hyacinth-red.[67]



74 75 76

Figs. 74–76. Penninite, Texas, Lancaster County (*Pirsson*).

Composition: The same as clinochlore (see above). Kammererite: peach-blossom red, sometimes mixed with clinochlore. According to Goldschmidt the mineral is hexagonal-holohedral. Rhodophyllite = kammererite. Rhodochrome is a compact, scaly variety; usually pink or red.

Analyses: Wood's chrome mine, Lancaster County. A. Pink, scaly. Genth, 1852, 122; mean of two analyses. B. Hermann, J. prakt. Chem., 53, 22, 1853. C–D. Smith and Brush, 1853, 47. E. Pearse, Am. J. Sci., 37, 222, 1864; green, average of two analyses. F. Pearse, 1864, 222. Reddish-green, average of two analyses. G. Dieffenbach, 1855, 534. An earlier erroneous analysis of Garrett, 1853, 332, is omitted.

	A	B	C	D	E	F	G
SiO_2	33.20	31.82	33.26	33.30	31.86	31.31	33.04
Al_2O_3	11.11	15.10	10.69	10.50	13.75	12.84	11.09
Cr_2O_3	6.85	0.90	4.78	4.67	2.15	2.98	5.91
Fe_2O_3	1.43	4.06	1.96	1.60	——	——	1.33
FeO	——	——	——	——	2.31	2.46	——
NiO	——	0.25	——	——	0.22	0.45	——
MgO	35.54	35.24	35.93	36.08	34.90	35.02	34.30
CaO	——	——	——	——	1.27	0.82	——
Li_2O	0.28	——	——	——	——	——	0.28
Na_2O		——	0.35	0.35	——	——	
K_2O	0.10				——	——	0.10
H_2O	12.95	12.75	12.64	13.25	13.98	13.20	12.81
	101.46	100.12	99.61	99.75	100.44	99.08	98.86

LOCALITIES: *Delaware County:* Moro Phillip's chrome mine, kammererite; *Chester County:* Scott's chrome mine (West Nottingham), kammererite; *Lancaster County:* Low's mine, and Wood's chrome mine: dark green or violet colored crystals, forming druses.

PROCHLORITE

$\left\{ \begin{array}{l} m\ H_4(Mg, Fe)_3Si_2O_9 \\ n\ H_4(Mg, Fe)_3Al_2SiO_9 \end{array} \right.$ MONOCLINIC

Color: grass-green, olive-green to blackish-green. Streak: uncolored or greenish. Translucent to opaque. Luster: of cleavage surfaces, feebly pearly. Form: massive, foliated, granular, six-sided tables often in divergent groups, fan-shaped or vermicular aggregates. Laminae flexible, not elastic. H = 1 – 2. Sp. gr. 2.78 – 2.96.

Analyses of chlorites: A. Prochlorite. Dana's farm, near Morrisville, Bucks County. Genth, Jr., Second Geol. Survey Penna. Rep., C6, 101, 1881. B. Thuringite? Willets, Adams County. Dark green scales. About 5.26% quartz was deducted from the analysis. Genth, 1876, 227. C. Rose's quarry, Lower Merion, Montgomery County. Dark green, scaly-granular. Obviously a serpentine mixed with some chloritic mineral. Genth, 1875, 134; analysis by Castle.

[67] Cooke, l. c.

	A	B	C
SiO_2	25.98	22.46	38.80
Al_2O_3	21.08	22.84	4.54
Fe_2O_3	3.72	2.85	3.97
FeO	19.96	35.70	3.63
MnO	——	0.10	——
MgO	18.29	6.11	35.78
H_2O	11.58	9.94	13.40
	100.61	100.00	100.12

LOCALITIES: Many writers have become accustomed to calling a chlorite "prochlorite" when it cannot be referred to the other members of the group. In many cases chloritic vermiculits, and even serpentines have been so called. Some of the chlorites whose localities are listed below may be prochlorite, but the absence of any specific data prevents their positive identification, which is extremely difficult owing both to the indefiniteness of the various "species" and to the fact that they are generally mixtures.

Adams County: Hamiltonban, and Littlestown; *Berks County:* Boyertown, Clymer mine, Fritz Island, Raudenbush mine, Ruth mine, Siessholtzville, and Wheatfield mines; *Bucks County:* Finney's quarry, Morrisville, and Taylor's Woods; *Chester County:* south of Bailey's farm (East Marlboro), Corundum Hill, and Poorhouse quarry; *Delaware County:* Avondale, Black Horse, Leiperville, Lenni, Mineral Hill, and Rose Tree; *Lancaster County:* Drumore township, and Gap mine; *Lehigh County:* South Mountain; *Montgomery County:* opposite Lafayette; *Northampton County:* Chestnut Hill, and Redington (thuringite?); *Philadelphia:* Fairmount Park, and Wissahickon Valley.

VENERITE. Color: green. Form: earthy masses resembling clay, consisting of minute transparent scales.

Composition: probably a mixture of a chlorite and chrysocolla.

Analysis: Pea green to apple green scales. Hunt, 1876, 328, analysis by G. W. Hawes; recalculated after deducting 6.22% sand.

SiO_2	30.73
Al_2O_3	14.67
Fe_2O_3	5.35
FeO	0.29
CuO	17.58
MgO	18.55
H_2O	12.83
	100.00

LOCALITY: *Berks County:* Jones mine.

CHALCODITE

$H_6(Fe, Mg)_2(Fe,Al)_2Si_6O_{18}$? MONOCLINIC

Color: yellowish or greenish-bronze. Luster: of cleavage surfaces submetallic or brass-like; also pearly to vitreous. Form: foliated plates, sometimes radiated. H = 2.76—3.

Analysis: French Creek mines, Chester County. "Glauconite." Bronze-yellow scales in cavities in feldspar. Knerr and Scheenfeld, Am. Chem. J., VI, 1885, 412.

SiO_2	52.86
Al_2O_3	7.08
Fe_2O_3	7.20
FeO	19.48
MgO	2.90
CaO	tr.
K_2O	2.23
Na_2O	tr.
H_2O	8.43
	100.18
Sp. gr.	2.2

LOCALITIES: *Chester County:* French Creek mines, bronze yellow plates in cavities in feldspar; *Montgomery County:* Huntingdon Valley Station.

CHLORITIC VERMICULITES

PAINTERITE,[68]—Color: bright golden yellow; dull green. Translucent. Luster: pearly; or dull vitreous. Form: foliated masses, micaceous; laminae flexible, inelastic.

Analyses: A–B. Painter's farm, Middletown, Delaware County. Bright golden yellow, strongly exfoliating before the blowpipe. Occurs in a brownish waxy mixture of plagioclase and serpentine. Clarke and Schneider, 1891, 248.

	A	B
SiO_2	34.86	33.95
TiO_2	tr.	tr.
Al_2O_3	11.64	12.52
Fe_2O_3	3.78	4.40
FeO	0.20	0.20
NiO	0.14	0.23
MgO	31.32	30.56
CaO	0.07	none
H_2O − 105°	1.64	1.56
H_2O − 250−300°	1.03	0.59
H_2O − Ign	15.75	16.46
	100.43	100.47

LOCALITY: *Delaware County:* Painter's farm on Dismal Run.

HALLITE,[69]—Color: green to yellow. Translucent to opaque. Dull. Form: rough six-sided prisms or plates. Cleavage: basal, perfect; laminae flexible, inelastic. The mineral exhibits asterism, and shows symmetrically arranged inclusions under the microscope. The optic angle varies in different parts of the same section from 0° to 18°. H = 1.5. Sp. gr. 2.368–2.373.

Analyses: Three miles south of Oxford, Chester County. A. Dark bluish-green, Clarke and Schneider, 1891, 245. B. Green, Cooke, 1873, 60; mean of 2 analyses by C. E. Munroe. C. Yellow. Cooke, 1873, 60; mean of 2 analyses by C. E. Munroe.

	A	B	C
SiO_2	35.54	35.89	35.26
Al_2O_3	9.74	7.45	7.58
Fe_2O_3	9.07	8.78	9.68
FeO	0.28	1.13	0.32
MnO	0.25	——	——
NiO	0.16	——	——
MgO	30.05	31.45	31.51
K_2O	——	0.46	0.61
H_2O–105°	2.64		
H_2O-250–300°	1.23	14.33	14.78
H_2O-red heat	10.91		
	99.87	99.49	99.74

LOCALITY: *Chester County:* three miles south of Oxford (East Nottingham).

LENNILITE,[70]—Color: white, bronze-yellow, dark green. Luster: pearly; or sub-metallic, bronze-like, also vitreous, dull. Translucent. Form: foliated masses; micaceous aggregates; laminae flexible, inelastic.

[68] Clarke and Schneider, 1891, 247; name given to the mineral by Jefferis. The name has also been given to the brownish, waxy mixture of plagioclase and serpentine which forms the matrix of the micaceous mineral.

[69] Cooke, 1874, 59; Cooke and Gooch, 1875, 453; Lewis, 1880, 250. The name was given to the mineral by Leeds, 1871, 70.

[70] Schrauf, 1882, 350; (incorrectly given lernilith). Clarke and Schneider, 1891, 245. The name has also been given to a variety of orthoclase (which see) occurring at Lenni.

Analyses: Lenni, Middletown, Delaware County. A. Silver-white. Clarke and Schneider, 1891, 245. B. Bronzy-brown, resembling jefferisite. Clarke and Schneider, 1891, 245. C. Dark green, resembling clinochlore. Clarke and Schneider, 1891, 245. D. Dull green, rough crystal plates. Mineral was dried at 100° until H_2O was constant. Mean of 3 analyses. Cooke and Gooch, 1875, 454. E. Eyerman, 1911, 15. Analysis is evidently of a mixture.

	A	B	C	D	E
SiO_2	36.72	35.09	34.90	38.03	37.53
TiO_2	0.18	0.58	0.10	——	0.24
Al_2O_3	10.06	12.05	10.60	12.93	2.16
Fe_2O_3	5.37	6.67	8.57	7.02	2.61
Cr_2O_3	0.26	0.46	0.23	——	0.26
FeO	0.12	0.11	0.22	0.50	1.56
MnO	0.31	0.27	0.17	——	0.51
NiO	0.20	0.20	0.19	——	——
CaO	——	——	——	——	5.76
BaO	——	tr.	——	——	——
MgO	29.40	27.62	28.21	29.64	32.42
Na_2O	——	——	——	——	0.03
Li_2O	——	——	——	tr.	——
K_2O	——	——	——	——	0.37
H_2O-105°	6.40	5.70	4.99		
H_2O-250–300°	2.68	1.98	1.60	11.68	16.39
H_2O-red heat	8.69	9.22	9.88		
	100.39	99.95	99.66	99.80	99.84
H_2O lost over H_2SO_4	6.92	5.84	5.21		

LOCALITY: *Delaware County:* Lenni.

PATTERSONITE.[71]—Color: bluish-gray. Streak: grayish. Translucent. Luster: pearly, inclining to submetallic. Form: aggregates of triangular plates. Cleavage: basal, laminae flexible, inelastic. H = 2. Sp. gr. 2.81.

Analyses: Unionville, Chester County. Micaceous. Genth, 1873, 398. A. Purest. B. Nearly pure. Sharples' (1869, 320) analysis was shown to be erroneous by Brush (*Suppl. to Dana's System, 1872, 18*) and is omitted.

	A	B
SiO_2	29.90	29.89
Al_2O_3	27.59	30.87
Fe_2O_3	3.12	
FeO	9.17	9.17
MgO	17.10	17.53
Li_2O	tr.	tr.
Na_2O	0.58	0.83
K_2O	2.33	2.41
H_2O	11.51	11.60
	101.30	102.30
Sp. gr.	2.810	

LOCALITY: *Chester County:* Corundun Hill (Newlin).

ROSBITE.—Color: pale brownish-yellow. Luster: pearly, waxy. Translucent to opaque. Form: vermicular aggregates. Soft. Composition: a much altered mica.

[71] Lea, 1867, 45. The mineral is near thuringite.

Analysis: West Nottingham, Chester County. Pale brownish-yellow, pearly, soft. A. J. Moses (*Sch. Mines Quarterly, 12, 73, 1891*), analysis by Genth.

SiO_2	35.38
Al_2O_3	30.30
MgO	14.66
H_2O	19.88
	100.22

LOCALITY: *Chester County:* an abandoned quarry, one and a half miles northwest of Sylmar.

LEIDYITE.[72]—Color: greenish-gray, grass-green to olive-green. Streak: white. Luster: waxy. Form: micaceous aggregates, films, incrustations; massive. H = 1—2. B. B. intumesces to a light yellowish-green glass. Dissolves readily in cold HCl, with partial gelatinization. Not soluble after ignition.

Analysis: Leiperville, Delaware County. Bluish-green to green vermicular incrustations of fine scales of resinous luster. Koenig, 1878, 85.

SiO_2	51.41
Al_2O_3	16.82
FeO	8.50
MgO	3.07
CaO	3.15
H_2O	17.08
	100.03

LOCALITIES: *Delaware County:* Leiperville, and Morgan Station?

EASTONITE.[73]—Color: silver-white to bright yellowish-green. Luster: pearly; vitreous. Transparent to translucent. Form: rough crystals, cleavage masses; scaly aggregates. Laminae: flexible, inelastic. Biaxial, small optic angle, optically—, dispersion $\rho < v$. Exfoliates and fuses readily on edges to a glass.

Analyses: A. Old Wolf Quarry, Chestnut Hill, Easton, Northampton County. "Chloritic vermiculite;" bright yellowish-green, in a compact tremolite rock. Clarke and Schneider, 1891, 250, analysis by Merrill. B. Light green. Chestnut Hill, Easton. Eyerman, 1911, 13–14.

	A	B
SiO_2	43.71	42.37
Al_2O_3	3.59	12.27
Fe_2O_3	0.90	0.92
FeO	——	0.60
CaO	——	0.24
MgO	38.58	30.15
K_2O	2.22	1.95
Na_2O	0.13	1.58
H_2O at 105°	0.46	
H_2O at 250–300°	0.09	9.99
H_2O at Ignition	10.70	
	100.38	100.07

[72] Koenig, 1878, 84–85.

[73] Eyerman, 1911, 14; "chloritic vermiculite" (Merrill), Clarke and Schneider, 1891, 250.

LOCALITY: *Northampton County:* Chestnut Hill (Easton).

ANALYSES OF OTHER UNNAMED CHLORITIC VERMICULITES: A. Unionville, Newlin, Chester County. Dull green: Clarke and Schneider, 1891, 248. B. Unionville; Fine granular green. Leeds, 1873, 25. C–D. Unionville. Olive-green. Genth, 1873, 395, analyses by Chatard.

	A	B	C	D
SiO_2	31.23	30.62	29.43	29.59
Al_2O_3	17.52	21.73	22.08	22.18
Cr_2O_3	0.14	——	——	——
Fe_2O_3	4.70	0.42	1.41	1.33
FeO	1.20	5.01	5.64	5.77
MnO	0.20	——	——	——
NiO	0.33	——	——	——
MgO	31.36	29.69	28.46	28.54
Li_2O	——	0.11	n.det.	n.det.
Na_2O	——	0.14	n.det.	n.det.
H_2O at 105°	1.08			
H_2O at 250–300°	0.40	12.26	12.40	12.40
H_2O at Ign	12.15			
	100.31	99.98	99.42	99.81

E. Unionville. Brownish-red, decomposed. Genth, 1873, 394, analysis by Koenig. F. Unionville. Yellowish-gray, decomposed. Genth, 1873, 394, analysis by Koenig. G. West Chestnut Hill, Easton, Northampton County. Blue-green, altered. Eyerman, 1911, 5. H. West Chestnut Hill, Easton. Light green, altered. Eyerman, 1911, 15.

	E	F	G	H
SiO_2	31.35	32.80	33.96	34.01
Al_2O_3	21.58	26.07	14.41	15.74
Fe_2O_3	14.17	9.80	——	——
FeO	——	——	3.81	5.70
MnO	——	——	——	——
CaO	——	——	0.12	0.14
MgO	16.67	17.70	34.20	31.20
H_2O	14.45	13.75	12.60	12.69
	98.22	100.12	99.10	99.48

JEFFERISITE[74]

Color: dark yellowish-brown, to light yellow. Luster: pearly on cleavage surfaces. Translucent. Form: broad crystals or crystalline plates. Cleavage: basal, eminent; laminae flexible, inelastic. H = 1.5. Sp. gr. 2.30.

Optical properties: Plates are generally twinned. Plane of optic axes coincides with the shorter diagonal of the prisms. Double refraction strong,—. Axial angles varies from 10°–27°, some plates are apparently uniaxial. Dispersion slight, $\rho < v$.

Composition:[75] a hydrated mica: $2(Fe,Mg)O.(Al,Fe)_2O_3.5\ SiO_2.5\ H_2O$.

Analyses: Brinton's quarry, Westtown, Chester County. A. Clarke and Schneider, 1890, 452. B. Brush, 1861, 370. C. Genth, 1873, 392, analysis by Koenig. D. Genth, 1873, 392, analysis by Chatard; FeO from analysis C.

[74] Brush, 1861, 369–370; 1866, 248.

[75] Cooke, 1874, 35; see also Lewis, 1880, 250. Lewis gives 34° for brown scales in a chloritic schist at Lafayette; and 37° for brown scales in a hornblende gneiss in Germantown; for the typical jefferisite from Chester County: 26° ±. Walker, 1899, 201, remarks that "phlogopite" from Westchester showed an optic angle divergence of 17°, it is probable that the specimen was jefferisite, as this mineral was once distributed as "phlogopite."

	A	B	C	D
SiO_2	34.20	37.10	33.35	34.40
Al_2O_3	16.58	17.57	17.78	16.63
Fe_2O_3	7.41	10.54	7.32	8.00
FeO	1.13	1.26	2.11	2.11
MgO	20.41	19.65	19.26	19.30
CaO	——	0.56	——	——
Na_2O	——	tr.	n.det.	n.det.
K_2O	——	0.43	n.det.	n.det.
H_2O (Ign.)	21.14	13.76	19.87	19.03
	100.87	100.87	99.69	99.47

H_2O over H_2SO_4	10.56
H_2O at 105°	——
H_2O at 250–300°	4.20
H_2O at red heat	6.18
H_2O at white heat	.20

Heated for 32 hours with dry HCl at 383–412°:
MgO removed 3.98
R_2O_3 removed 1.38
(Clarke and Schneider, 1890, 452)

LOCALITIES: *Chester County:* Beryl Hill, Corundum Hill (Newlin), and Brinton's quarry (large brown crystals); *Delaware County:* Adele, Boothwyn, Mineral Hill, Radnor, and Tyler's farm (Middletown); *Lancaster County:* Wood's chrome mine; *Philadelphia:* O'Neill's quarry, and West Philadelphia.

OTHER HYDROUS SILICATES

SERPENTINE	$H_4Mg_3Si_2O_9$	Monoclinic
DEWEYLITE	$H_4Mg_4Si_3O_{12}.4H_2O$	Amorphous
GENTHITE	$H_4Mg_2Ni_2Si_3O_{12}.4H_2O$	Amorphous
TALC	$H_2Mg_3Si_4O_{12}$	Monoclinic
SEPIOLITE	$H_4Mg_2Si_3O_{10}$	Amorphous
COLERAINITE	$H_8Mg_2AlSiO_8$	Trigonal
NEOLITE		Amorphous
AQUACREPTITE		Amorphous
SAPONITE		Amorphous
KAOLINITE	$H_4Al_2Si_2O_9$	Monoclinic
HALLOYSITE	$H_4Al_2Si_2O_9 + H_2O$	Amorphous
PYROPHYLLITE	$H_4Al_2Si_4O_{12}$	Monoclinic?
ALLOPHANE	$Al_2SiO_6.5H_2O$	Amorphous
URANOPHANE	$CaU_2Si_2O_{11}.6H_2O$	Orthorhombic
CHRYSOCOLLA	$CuSiO_3.2H_2O$	Amorphous
CHLOROPAL	$(Fe, Al)_2Si_2O_9.5H_2O$	Amorphous
HISINGERITE		Amorphous

SERPENTINE

$H_4Mg_3Si_2O_9$ MONOCLINIC

Color: light to dark green, white, brownish-yellow to brownish-red; becomes yellowish-gray on exposure. Streak white. Transparent to opaque. Luster: subvitreous, greasy, waxy, or earthy. Form: usually massive; sometimes lamellar, or delicately fibrous. H = 2.5–4. Sp. gr. 2.50–2.65.

Composition: $H_4Mg_3Si_2O_9$; SiO_2 44.1, MgO 43.0, H_2O 12.9, = 100. FeO replaces some MgO; a small amount of NiO is usually present.

Varieties: Precious or noble: rich oily green, translucent. Bowenite: apple green to greenish-white, massive, fine granular, resembling nephrite. H = 5.5–6. Sp. gr. 2.59–2.78. Williamsite:[76] apple-green, translucent, massive or lamellar. H = 4.5. Sp. gr. 2.59–2.64. Picrolite:[77] grayish-green to dark green, columnar or pseudo-fibrous, with a long splintery fracture. Antigorite: leek-green, thin lamellar, laminae easily separable into translucent folia; feel smooth. H = 2.5. Sp. gr. 2.622. Marmolite: greenish- or bluish-white, luster pearly, thin foliated,

[76] Shepard, 1848, 249.
[77] Baltimorite is referable to this variety.

aminae brittle but separable. Sp. gr. 2.41. Retinalite: honey-yellow to light oily green, waxy lor resinous luster; massive. Porcellophite: resembling compact lithomarge, with a smooth porcelain-like fracture. H = 3.5. Sp. gr. 2.47–2.52. Thermophyllite: light brown to silvery white, luster pearly; form: masses of small scales. H = 2.5. Sp. gr. 2.61. Chrysotile (serpentine asbestus): greenish-white, light green to olive-green, yellow or brown. Luster: silky. Delicately fibrous, fibres easily separable and usually flexible. Sp. gr. 2.219.

Analyses: A. Williamsite. Low's mine, Lancaster County. Green, sometimes laminated. Dana, 1850, 692; analysis by Brush. B. Williamsite. Low's mine. Hermann, 1853, 31. C–D. Williamsite. Smith and Brush, 1853, 134. E. Slaty serpentine, Low's mine. Silliman, Jr., 1849, 134. F. Picrolite. Wood's mine, Lancaster County. Bluish green, Rammelsberg, 1860, 526. G. Picrolite. Wood's mine. Dana, 1850, 692, analysis by Brewer.

An earlier inaccurate analysis by Shepard (1848, 250) is omitted.

	A	B	C	D	E	F	G
SiO_2	45.02	44.50	41.60	42.60	44.58	43.79	44.25
Al_2O_3	3.35	0.75	tr.	tr.	3.03	——	4.90
Fe_2O_3	——	——	——	——	——	——	——
FeO	——	1.39	3.24	1.62	6.15	2.05	3.67
NiO	——	0.90	0.50	0.40	tr.	——	0.69
MgO	37.75	39.71	41.11	41.90	34.51	41.03	34.00
H_2O	13.01	12.75	12.70	12.70	12.38	12.47	12.32
	99.13	100.00	99.15	99.22	100.65	99.34	99.83
Sp. gr.		2.60				2.557	

H. Precious. Leslie's farm, Newlin, Chester County. Light green to pale yellow. Eyerman, 1911, 15–16. I. Edward's quarry, Willistown, Chester County. Green to grayish-black. Eyerman, 1911, 15–16. J. East Goshen, Chester County. Yellowish. Sharples, 1866, 272. K. Middletown, Delaware County. "Meerschaum." Eyerman, 1911, 15. L. Porcellanous, resembling compact lithomarge. Middletown, Delaware County. Dana, 1868, 467, analysis by Burton. An old analysis of serpentine ("fahlunite") from Germantown by Nuttall (1822, 23) is omitted.

	H	I	J	K	L
SiO_2	40.23	36.59	43.89	44.58	44.08
Al_2O_3	1.01	tr.	——	tr.	0.30
Fe_2O_3	2.43	8.84	——	——	——
FeO	3.50	1.05	1.38	2.13	1.17
CaO	——	——	——	——	0.37
MgO	41.10	38.85	40.48	39.55	40.87
Na_2O	——	1.46	——	——	——
H_2O	11.54	13.41	13.45	12.91	13.70
	99.81	100.20	99.20	99.17	100.49
Sp. gr.		2.610			2.48

	M	N	O	P	Q	R
SiO_2	42.11	42.14	41.46	42.87	39.83	44.21
Al_2O_3	——	——	——	0.26	6.39	2.72
Fe_2O_3	——	——	——	——	——	——
FeO	5.47	2.06	0.99	2.35	1.71	0.52
CaO	0.68	tr.	——	1.04	0.07	0.26
MgO	37.80	41.61	44.68	40.40	39.92	40.55
Na_2O	——	——	——	——	1.11	——
H_2O	14.13	14.20	14.07	12.98	10.43	12.43
	100.19	100.01	101.20	99.90	99.46	100.69
Sp. gr.	2.559			2.510	2.718	2.363

M. Cornwall, Lebanon County. Light green. Eyerman, 1911, 15–16. N. Ruth's mine, Berks County. Genth, 1885, 42, analysis by Keller. O. Wheatfield mine, Berks County. Genth, 1885, 42, analysis by Keller. P. Porcellophite. Delaware River quarry, Easton, Northampton County. Green. Eyerman, 1911, 15–16. Q. Thermophyllite. Delaware River quarry, Easton. Eyerman, 1911, 15–16. R. Easton. White. Eyerman, 1911, 15–16.

S. Delaware River quarry, Easton. Light green. Eyerman, 1911, 15–16. T. Delaware River quarry, Easton. Dark oily green. Eyerman, 1911, 15–16. U. William's Bushkill quarry, Easton. Precious. Eyerman, 1911, 15–16. V. William's Delaware quarry, Easton. Dark oily green. Eyerman, 1911, 11–15. W. Easton. Precious. Thompson, 1828, 49. X. Verdolite quarry, Easton. Altered. Eyerman, 1911, 15–16.

	S	T	U	V	W	X
SiO_2	45.23	44.77	42.44	43.28	41.55	41.68
Al_2O_3	——	——	1.13	——	——	11.33
Fe_2O_3	——	0.51	0.26	——	3.90	3.47
FeO	3.61	4.77	1.69	2.50	——	0.33
MnO	——	——	——	——	——	0.80
CaO	——	——	0.23	0.23	——	tr.
MgO	39.59	45.09	41.45	42.55	40.15	37.75
H_2O	11.60	4.96	12.70	11.44	13.70	4.55
	100.03	100.10	99.90	100.00	99.30	99.91
Sp. gr.	2.517	2.417	2.793	2.487	3.39	

LOCALITIES: *Berks County:* Boyertown, Fritz Island, Jones mine, Ruth mine, Topton, and Wheatfield mines; *Bucks County:* Flushing; *Chester County:* Sylmar, Brinton's quarry, Corrine Corundum Hill (antigorite, picrolite, retinalite), Edward's quarry, French Creek mines, Goat Hill (marmolite), Marlboro, Marshall's quarry, McCall's quarry, Northbrook, Scott's chrome mine, Taylor's quarry (retinalite, chrysotile), Webb's quarry; *Delaware County:* Blue Hill (chrysotile and picrolite), Castle Rock (chrysotile), Elwyn (chrysotile), The Hunt (retinalite), Moro Phillip's chrome mine (chrysotile), Lenni, Radnor (chrysotile, marmolite), Rose Tree, and Williamson School; *Lancaster County:* Black Barren Springs, Carter's chrome mine (red), Low's mine (picrolite and williamsite), Rock Springs Run (chrysotile), Texas (marmolite), and Wood's chrome mine (marmolite, picrolite, and williamsite); *Lebanon County:* Cornwall; *Montgomery County:* Rose's quarry (antigorite). *Northampton County:* Chestnut Hill (precious or noble, retinalite, marmolite, bowenite, porcellophite, chrysotile, and thermophyllite); *Philadelphia:* Prince's quarry, and Wissahicken Valley; *York County:* Spring Grove, and York Valley.

DEWEYLITE

$H_4Mg_4Si_3O_{12}.4H_2O$ AMORPHOUS

Color: white, yellow, brown, reddish or greenish. Translucent. Luster: resinous, waxy, greasy. Form: massive, stalactitic or botryoidal coatings, resembling gum arabic or resin. Brittle and often much cracked. H = 2–3.5. Sp. gr. 2.0–2.2.

Composition; $H_4Mg_4Si_3O_{12}.4H_2O$; SiO_2 40.2, MgO 35.7, H_2O 24.1, = 100.

Analyses: A. Wood's mine, Lancaster County. Brownish, resinous botryoidal masses. Dana, 1854, 236, analysis by Brush. B. The Hunt, Delaware County. White, jasper-like, massive. Eyerman, 1911, 17. C. Ruth's mine, Berks County. Yellow, waxy. Genth, 1885, 41, analysis by Keller. D–E. Ruth's mine, Berks County. Whitish and brownish resinous coatings with aragonite and serpentine. Brunner and Smith, 1883, 280.

	A	B	C	D	E
SiO_2	43.15	42.29	39.32	45.65	42.34
Al_2O_3	tr.	——	——	——	——
Fe_2O_3	——	1.92	——	0.20	1.39
FeO	——	——	0.51	——	——
MgO	35.95	39.90	41.14	34.38	36.77
CaO	——	——	tr.	tr.	tr.
H_2O	20.25	16.16	18.41	19.49	19.03
	99.35	100.27	99.38	99.72	99.53
Sp. gr.				2.3	

LOCALITIES: *Berks County:* Fritz Island, Ruth mine, and Wheatfield mines; *Chester County:* Brinton's quarry, Corundum Hill (Newlin), Goat Hill, and Taylor's quarry; *Delaware County:* The Hunt, Mineral Hill, and Radnor; *Lancaster County:* Carter's mine, and Wood's chrome mine; *Philadelphia:* Prince's quarry.

GENTHITE[78]

$H_4Mg_2Ni_2Si_3O_{12}.4H_2O$ AMORPHOUS

Color: pale apple green, yellowish. Streak: greenish-white. Opaque to translucent Luster: resinous. Form: mammillary or stalactitic coatings. H = 3–4. Sp. gr. 2.409.

Composition: $H_4Mg_2Ni_2Si_3O_{12}.4H_2O$; SiO_2 34.8, NiO 28.8, MgO 15.5, H_2O 20.9, = 100.

Analyses: A. Apple-green, resinous, mammillary or stalactitic coatings. Woods mine, Lancaster County. Genth, 1851, 488. B. "Pimelite;" analysis of an apple-green, micaceous mixture, probably of talc and genthite. Radnor, Delaware County. Goldsmith, 1893, 174.

	A	B
SiO_2	35.36	45.93
NiO	30.64	7.69
FeO	0.24	——
MgO	14.60	34.44
CaO	0.26	——
H_2O	19.09	11.68
	100.19	99.74

LOCALITIES: *Delaware County:* Radnor; *Lancaster County:* Low's mine, and Wood's chrome mine; *Montgomery County:* Rose's quarry; *Philadelphia:* Prince's quarry.

TALC

$H_2Mg_3Si_4O_{12}$ MONOCLINIC

Color: apple green to silvery-white, greenish-gray, dark green; streak white. Subtransparent to translucent. Luster: pearly. Form: foliated masses; granular massive (steatite), compact or cryptocrystalline, slaty ("indurated talc"), rarely in tabular crystals. H = 1–1.5. Sp. gr. 2.7–2.8. $2E$ = 12° to 15°, Lafayette, Pa. (Lewis[79]).

Composition: $H_2Mg_3Si_4O_{12}$: SiO_2 63.5, MgO 31.7, H_2O 4.8, = 100. NiO is sometimes present.

Analysis: A few hundred yards, S. S. W. of Castle Rock, Delaware County. "Indurated talc." Grayish olive-green, cryptocrystalline, slightly scaly. H = 2. Sp. gr. 2.789. Genth, 1882, 394.

SiO_2	62.48
TiO_2	tr.
Cr_2O_3	0.13
Al_2O_3	0.59
NiO	0.16
FeO	4.95
MgO	27.60
Ignition	4.81
Chromite	0.20
	100.92

LOCALITIES: *Allegheny County:* Pittsburgh? *Berks County:* Fritz Island, Jones mine, and Topton; *Chester County:* Avondale? Black Horse (indurated), Sylmar, Brinton's quarry, Cope's quarry, Corundum Hill, Embreeville, Marshall's quarry, Marlboro, Scott's chrome mine, and Taylor's quarry; *Delaware County:* Black Horse, Blue Hill, Castle Rock, Chelsea, Lenni, Mineral Hill, Moro Phillips chrome mine, Newton Square, Rockdale, Rose Tree, Village Green, and Worrall; *Lancaster County:* Low's mine, Pleasant Grove, and White Rock; *Montgomery*

[78] Described by Genth (1851, 487) as "nickel-gymnite" (gymnite = deweylite); named genthite by Dana, Am. J. Sci., 44, 256, 1867).

[79] Lewis, 1880, 248.

County: opposite Lafayette, and Rose's quarry; *Northampton County:* Chestnut Hill; *Philadelphia:* Bustleton, Prince's quarry,[80] and Wissahickon Valley.

SEPIOLITE

$H_4Mg_2Si_3O_{10}$ AMORPHOUS

Color: white, gray, faintly yellowish. Opaque. Form: compact masses, earthy or clay-like. Feel smooth. Dry masses float on water. H = 2–2.5. Sp. gr. 2. Adheres to the tongue.

Composition. $H_4Mg_2Si_3O_{10}$; SiO_2 60.8, MgO 27.1, H_2O 12.1, = 100. The mineral may contain a considerable admixture of magnesite. Some hygroscopic water may be present.

LOCALITIES: *Chester County:* Brinton's quarry, and Goat Hill; *Delaware County:* Black Horse, Elam, The Hunt, Mineral Hill, and Radnor.

COLERAINITE

$H_8Mg_2AlSiO_8$ TRIGONAL

Color: white, to pale pinkish white. Luster: vitreous, or pearly, often dull. Form: rosettes of thin trigonal plates, granular or compact masses. H = 2.5–3. Sp. gr. = 2.51.

LOCALITY: *Chester County:* Brinton's quarry; and Sylmar.

NEOLITE

Color: green or yellow. Luster: silky or earthy. Form: massive, or silky fibrous. H = 1–2. Sp. gr. 2.77.

Composition: a doubtful colloidal hydrous silicate of Al, Fe, and Mg.

Analysis: Rose's quarry, Lower Merion, Montgomery County. Yellowish or grayish-white seams in metaperidotite. Genth, 1875, 105, analysis by Harry W. Jayne.

SiO_2	61.70
Al_2O_3, Fe_2O_3	6.85
MgO	27.95
H_2O	5.00
	101.50

LOCALITIES: *Chester County:* French Creek mines? *Montgomery County:* Rose's quarry.

AQUACREPTITE[81]

Color: yellowish-brown. Streak: orange-yellow. Dull. Form: amorphous masses, with a flat conchoidal fracture. Brittle. Adheres to the tongue. Falls to pieces in water with a crackling noise (hence the name). H = 2.5. Sp. gr. 2.05–2.08.

Composition: a doubtful colloidal hydrous silicate of Al, Fe, and Mg.

Analyses: Strode's Mill, East Bradford, Chester County. Shepard, 1868, 256. Analysts: A. J. H. Eaton; B. Henry C. Humphrey; C. C. U. Shepard.

	A	B	C
SiO_2	43.03	41.56	41.00
Al_2O_3	5.56	6.71	4.00
Fe_2O_3	12.30	12.45	13.30
MgO	19.58	n. det.	17.60
H_2O	17.40	16.00	23.00
	97.87		98.90

LOCALITY: *Chester County:* Strode's Mill (East Bradford). Another mineral, probably halloysite, possessing the same property of breaking into pieces with a cracking noise, has been

[80] Lewis (1880, 248) gave the following optic angles (2E) for talc from this quarry: exfoliating fan-shaped crystals 12°40′, transparent and foliated talc 15°.

[81] Shepard, 1868, 256.

locally called aquacreptite. It is found at the following localities: *Delaware County:* Upper Darby; *Montgomery County:* Marble Hall; *Philadelphia:* George's Hill, Overbrook, and West Philadelphia.

SAPONITE

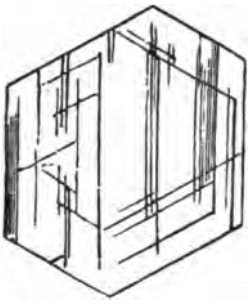
Color: white, gray, yellow, or greenish. Luster greasy. Soft like butter. Does not adhere to the tongue. Form: massive. Sp. gr. 2.24–2.30.

Composition: a colloidal silicate of Mg and Al.

LOCALITY: *Delaware County:* Leiperville?

KAOLINITE

$H_4Al_2Si_2O_9$ MONOCLINIC



77

Fig. 77. Kaolinite, Summit Hill, Carbon County (*Johnson and Blake*).

Color: white, gray, yellowish. Scales are transparent to translucent. Luster: of plates, pearly; of masses, pearly to dull earthy. Form: thin pseudo-rhombohedral or pseudo-hexagonal scales or plates, sometimes twinned (Mica law); usually in clay-like masses, compact, friable or mealy. Cleavage: basal, perfect. Flexible, inelastitic. Usually unctuous and plastic. H = 2–2.5. Sp. gr. 2.6–2.63.

Composition: $H_4Al_2Si_2O_9$; SiO_2 46.5, Al_2O_3 39.5, H_2O 14.0, = 100. The H_2O is given off above 330°.

Synonym: pholerite.

Analyses: A. Pholerite. Tamaqua, Schuylkill County. Mean of two analyses of scales purified by HCl. Genth, 1859, 251. B. Pholerite. Summit Hill, Carbon County. Scales purified by HCl. Johnson and Blake, 1867, 354. C. Kaolin. Chestnut Hill, Lancaster County. Genth, 1875, 119. D. Kaolin. East Nottingham, Chester County. Genth, 1875, 119.

	A	B	C	D
SiO_2	46.90	45.93	67.1	46.34
Al_2O_3	39.60	39.81	20.1	36.32
Fe_2O_3	——	——	3.9	0.64
MgO	——	——	0.7	tr.
CaO	——	——	0.1	0.04
Na_2O	0.17	——	tr.	tr.
K_2O	——	——	2.2	0.77
H_2O	13.80	14.02	5.9	13.75
Orthoclase	——	——	——	1.04
Quartz	——	——	——	1.10
	100.47	99.76	100.0	100.00

LOCALITIES:[82] *Berks County:* twelve miles north of Douglassville, Jones mine, Longswamp, Fleetwood, and Mt. Penn; *Carbon County:* Summit Hill; *Chester County:* Kennett Square, and Toughkenamon; *Delaware County:* Brandywine Summit, Black Horse, Green's farm near Upland, Trainer, and Upper Darby; *Lancaster County:* Chestnut Hill; *Montgomery County:* West Conshohocken; *Philadelphia:* Branchtown, Fairmont Park, Germantown, Logan, Ryers, West Philadelphia, and Wissahickon Station; *Schuylkill County:* Tamaqua (pholerite), and Pottsville (pholerite).

HALLOYSITE

$H_4Al_2Si_2O_9 + H_2O$ AMORPHOUS

Color: white gray, yellow, greenish, bluish, reddish. Translucent to opaque. Luster: pearly, waxy, or dull. Form: massive, clay-like or earthy. H = 1–2. Sp. gr. 2.0–2.20.

Analyses: A. "Cerolite." Corundum Hill (Newlin), Chester County. Yellowish-white,

[82] A number of halloysites may be included in the list.

massive. Smith and Brush, 1853, 211. B. "Sauconite." Friedensville, Lehigh County. Pale yellowish-white clay. Genth, 1875, 120, analysis by W. Theo. Roepper. C. "Sauconite." Friedensville, Lehigh County. Ochre yellow, Dried one hour at 105° C. Genth, 1875, 120, analysis by Roepper. D. "Sauconite." Friedensville, Lehigh County. Pale yellow. Dana, 1868, 409, analysis by Blake. E. A manganiferous clay. Sampson mine, South Easton, Northampton County. Brownish-pink. Eyerman, 1911, 18.

	A	B	C	D	E
SiO_2	44.50	48.94	46.45	41.36	23.23
Al_2O_3	25.00	10.66	7.41	8.04	9.71
Fe_2O_3	——	3.85	14.28	9.55	4.85
MnO	tr.	——	——	——	42.15
ZnO	——	26.95	22.86	32.24	——
MgO	7.75	——	0.97	1.02	——
CaO	——	2.42		——	2.91
H_2O 24 hours over H_2SO_4	1.04				
H_2O on heating to 212°	8.81	7.06	6.73	7.76	17.15
H_2O at red heat	12.54				
	99.64	99.88	98.70	99.97	100.00

LOCALITIES: *Chester County:* Bailey's farm in East Marlboro (lithomarge), and Coundrum Hill (Newlin); *Delaware County:* Boothwyn (lithomarge); *Lehigh County:* Friedensville (sauconite); *Northampton County:* South Easton; *Philadelphia:* Prince's quarry? (lithomarge).

PYROPHYLLITE

$H_2Al_2Si_4O_{12}$ MONOCLINIC?

Color: white, gray, greenish, yellowish-brown. Subtransparent to opaque. Luster: pearly; dull or bright. Form: foliated, radiated, lamellar, fibrous, compact, cryptocrystalline, slaty. Cleavage: basal, eminent. Laminae flexible, not elastic. Feel: greasy. H = 1–2. Sp. gr. 2.8–2.9.

Composition: $H_2Al_2Si_4O_{12}$; SiO_2 66.7, Al_2O_3 28.3, H_2O 5.0, = 100.

Analyses: A. Cross Creek Colliery, near Drifton, Luzerne County. Genth, 1882, 402. B. North Mahanoy Colliery, Mahanoy City, Schuylkill County. Genth, 1879, 280.

	A	B
SiO_2	65.77	66.61
Al_2O_3	29.36	27.63
Fe_2O_3	0.12	0.16
MgO	——	0.10
H_2O	4.85	5.43
	100.10	99.93

LOCALITIES:[83] *Luzerne County:* at Drifton and Gowen (white or yellowish white, cryptocrystalline, in the Buck Mountain Seam); *Philadelphia:* Prince's quarry; *Schuylkill County:* Mahanoy City.

ALLOPHANE

$Al_2SiO_5.5H_2O$ AMORPHOUS

Colorless, silvery white, pale sky blue, greenish, yellow. Streak: uncolored. Translucent. Luster: vitreous, subresinous, pearly; bright. Form: incrusting, mammillary or stalactitic. H = 3. Very brittle. Sp. gr. 1.85–1.89.

Composition: $Al_2SiO_5.5H_2O$; SiO_2 23.8, Al_2O_3 40.5, H_2O 35.7, = 100.

Analysis: Ballietsville, Lehigh County. White mammillary and stalactitic coatings on limonite. Smith, 1883, 272.

[83] Pyrophyllite slates occur in Lycoming (Cogan House and Pine townships), and Tioga counties; Abraham Meyer, Pyrophyllite slates in northern Pennyslvania, Proc. Acad. Nat. Sci. Phila., 45, 1893, 197–200.

SiO_2	21.39
Al_2O_3	35.20
H_2O	40.86
$CaMg(CO_3)_2$	1.96
	99.41

LOCALITIES: *Berks County:* Jones mine; *Chester County:* Chester Springs, and Trimble's mine; *Delaware County:* Avondale, Chelsea (silver-white, greenish, or bluish mammillary coatings on gneiss); Franklin Paper Mills; *Lebanon County:* Cornwall; *Lehigh County:* Friedensville, and Ironton.

URANOPHANE

$CaU_2Si_2O_{11}.6H_2O$ ORTHORHOMBIC

Color: lemon- or straw-yellow. Luster: vitreous, pearly. Form: incrusting, aggregates of minute fibrous or acicular crystals; stellate or radiating. H = 2–3. Sp. gr. 3.81–3.90.

Composition: $CaU_2Si_2O_{11}.6H_2O$; SiO_2 13.9, UO_3 67.0, CaO 6.5, H_2O 12.6, = 100.

Synonym: uranotile.

LOCALITIES: *Delaware County:* Avondale; *Philadelphia:* on Broad Street at Olney Avenue, and Duncannon Avenue; and McCrea's quarry (Mt. Airy).

CHRYSOCOLLA

$CuSiO_3.2H_2O$ AMORPHOUS

Color: green, bluish-green, deep blue. Streak: white. Translucent to opaque. Luster: vitreous, shining; earthy. Form: botryoidal, incrusting or filling seams; earthy or opal-like masses; cryptocrystalline. Fracture conchoidal. Rather sectile; usually brittle. H = 2 – 4. Sp. gr. 2–2.4.

Composition: $CuSiO_3.2H_2O$; SiO_2 34.3, CuO 45.2, H_2O 20.5, = 100.

LOCALITIES: *Berks County:* Birdsboro, Fritz Island, and Jones mine; *Bucks County:* Finney's quarry; *Chester County:* French Creek mines; *Delaware County:* Avondale, and Strath Haven Inn; *Lebanon County:* Cornwall; *Montgomery County:* Ecton mine, Hendricks Station, Marble Hall, Perkiomen mine, Pottstown, and Sumneytown; *Philadelphia:* Frankford, Germantown, Prince's quarry, and Rittenhouse quarry.

CHLOROPAL

$(Fe, Al)_2Si_2O_9.5H_2O$ AMORPHOUS

Color: yellow, greenish-yellow to dark green. Opaque, translucent. Luster: vitreous, earthy. Form: compact, massive, adheres feebly to the tongue. H = 2.5–4.5. Sp. gr. 1.727–1.870.

Composition: $Fe_2Si_2O_9.5H_2O$; SiO_2 41.9, Fe_2O_3 37.2, H_2O 20.9, = 100. Al_2O_3 may replace Fe_2O_3.

Analyses: Near Mountainville, Lehigh Mountain, Lehigh County. Soft, smooth, earthy. Sp. gr. 2.033. Smith, 1883, 277–279. A. Yellow. B. Dark yellow. C. Greenish yellow. D. Yellowish green. E. Yellowish green. F. Nearly white. G. Light yellow. H. Brownish yellow. I. Brownish yellow. J. Brownish yellow. K. Brown. L. Yellowish brown.

	A	B	C	D	E	F
SiO_2	40.20	40.81	42.31	41.16	41.41	44.52
Fe_2O_3	39.52	39.30	38.18	30.79	35.35	11.04
FeO	0.40	——	tr.	0.21	——	——
Al_2O_3	——	——	——	2.05	3.04	25.95
MgO	tr.	——	——	——	——	tr.
K_2O	tr.	——	——	4.54	——	0.94
P_2O_5	tr.	——	——	——	——	——
H_2O	19.61	19.79	18.65	20.79	20.45	17.65
	99.73	99.90	99.14	99.54	100.25	100.10

	G	H	I	J	K	L
SiO_2	42.79	42.37	41.35	41.13	43.54	43.00
Fe_2O_3	39.19	38.17	39.09	38.97	39.52	37.50
FeO	——	tr.	——	——	——	——
MgO	——	tr.	——	tr.	——	——
P_2O_5	——	tr.	——	tr.	——	——
H_2O	19.09	19.27	19.31	19.31	17.71	19.36
	101.07	99.83	99.75	99.41	100.77	99.86

LOCALITIES: *Berks County:* Longswamp Church; *Lebanon County:* Cornwall; *Lehigh County:* Mountainville and Zionsville.

HISINGERITE

Color: brownish-black to black. Streak: yellowish brown. Luster: greasy, vitreous. Form: amorphous, compact, incrusting masses. H = 3. Sp. gr. 2.5–3.0.

Composition: a colloidal Fe silicate, probably a mixture.

Analysis: Gap Mine, Lancaster County. Black, amorphous. Rand, 1872, 304. 1.13% gangue omitted from analysis.

SiO_2	35.40
Fe_2O_3	27.46
FeO	12.53
H_2O at 106°	14.30
H_2O at red heat	9.89
	99.58

LOCALITY: *Lancaster County:* Gap nickel mine.

TITANO-SILICATE

TITANITE	$CaTiSiO_5$	Monoclinic

COLUMBATES, TANTALATES

MICROLITE	$Ca_2Ta_2O_7$	Isometric
FERGUSONITE	(Y, Er, Ce) (Cb, Ta)O_4	Tetragonal
COLUMBITE	(Fe, Mn)Cb_2O_6	Orthorhombic
SAMARSKITE	$R_4(Cb, Ta)_2O_7$	Orthorhomic
EUXENITE	$R_2(CbO_3)_3 . R_2(TiO_3)_3 . {}^3/_2H_2O$ [R = $^1/_3$(Y, Ce), $^1/_3$(UO, ThO, Fe, Ca)]	Orthorhombic

TITANITE

$CaTiSiO_5$ MONOCLINIC

Color: Yellow, green, gray, brown, black. Streak: white. Transparent to opaque. Luster: adamantine to resinous. Form: wedge-shaped crystals, often twinned. H = 5–5.5. Sp. gr. 3.4–3.56.

Crystallography; Monoclinic; $a : b : c = 0.7547 : 1 : 0.8540$; $\beta = 119°43'$.

$p_0 : q_0 : r_0 = 1.1316 : 0.7417 : 1$; $\mu = 60°17'$.

Common forms: *c* (001), *m* (110), *n* (111), *a* (100), *x* (102), and *l* ($\bar{1}12$). Habit: tabular parallel to *c;* prismatic by the extension of *m*. Twins common, twin-plane *a*, contact and cruciform penetration twins. Cleavage: *m* distinct, *a* and *l* imperfect.

Composition: $CaTiSiO_5$; SiO_2 30.6, TiO_2 40.8, CaO 28.6, = 100. Fe is usually present, and sometimes Mn.

Synonym: sphene.

Analyses: A–B. Tioga station, Philadelphia. Liver brown crystals in hornblende. Genth, Second Geol. Surv. Penna. Rep., C6, 1881, 130. C. Two miles from Hosensack Station, Lehigh County. Dark brown crystals. Smith and Knerr, 1885, 412.

	A	B	C
SiO_2	30.60	(31.36)	34.87
TiO_2	37.23	37.02	43.41
Al_2O_3	0.67	0.47	——
FeO	0.90	0.90	——
MnO	tr.	tr.	——
MgO	0.24	tr.	——
CaO	29.50	29.38	21.75
Ignition	0.99	0.87	——
	100.13	(100.00)	100.03
Sp. gr.	3.596		3.45

LOCALITIES: *Berks County:* two miles north of Jones mine; Dale, and Rauch's mine (Huff Church); *Bucks County:* Neshaminy Falls, and Vanartsdalen's quarry; *Chester County:* Black Horse, Burnett's quarry, Cloud's farm (Kennett, yellow), Coventryville, London Grove, Nevin's quarry, Osborn Hill, Pierce's Paper Mill (Kennett, yellow), and Pughtown; *Delaware County:* Avondale, Boothwyn (yellow and green, transparent crystals up to 2.5 cm.); Darby, Leiperville, Morton (Mullen's quarries, yellowish green transparent, twinned crystals, from 2.5 to 8 cm. long); *Lehigh County:* near Hosensack Station; *Montgomery County:* Pencoyd; *Northampton County:* Campbell's Hump, and Chestnut Hill; *Philadelphia:* Chestnut Hill, Fairmount Park, Frankford, Germantown, O'Neill's quarry, Overbrook, Rittenhouse quarry, Tioga, Wingohocking Creek, and Wissahickon Valley.

MICROLITE

$Ca_2Ta_2O_7$ ISOMETRIC

Color: pale yellow to brown. Luster: resinous. Translucent to opaque. Form: octahedral crystals, usually very minute. Brittle. H = 5.5. Sp. gr. 5.4–6.1.

Composition: $Ca_2Ta_2O_7$, but containing F many of the rare earth metals.

LOCALITY: *Delaware County:* Mineral Hill.

FERGUSONITE

(Y, Er, Ce)(Cb, Ta)O_4 TETRAGONAL

Color: brownish black, liver brown. streak: pale brown. Subtranslucent to opaque. Luster: vitreous or submetallic, externally dull. Form: imbedded grains of masses. Fracture: subconchoidal. H = 5.5–6. Brittle. Sp. gr. 5.80–5.84, diminishing to 4.3 when much hydrated.

LOCALITY: *Delaware County:* Mineral Hill.

COLUMBITE

(Fe, Mn)Cb_2O_6 ORTHORHOMBIC

Color: iron-black, brownish-black; frequently irridescent. Streak: dark red to black. Opaque. Luster: submetallic; subresinous. Form: short prismatic crystals, groups of parallel individuals; massive. H = 6. Brittle. Sp. gr. 5.3–7.3.

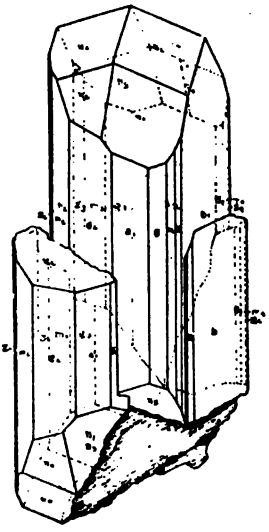
Crystallography: Orthorhombic; a:b:c = 0.4023 : 1 : 0.3580.

$p_0 : q_0 : r_0 = 0.8899 : 0.3580 : 1.$

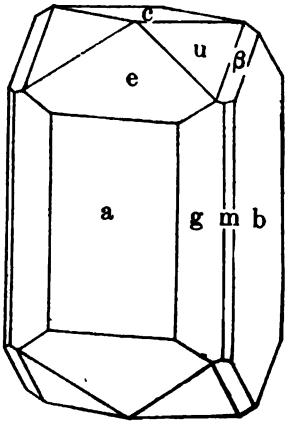
Forms: *a* (100), *b* (010), *c* (001), *g* (110), *m* (130), *z* (150), *e* (201), *u* (111), *n* (211), *β* (121), and (412)? (Genth, 1889, 50; Smith, 1919, 121). Habit: short prismatic; thin tabular parallel to *b*. Twins common, twin-plane *e* (201), contact type, usually heart-shaped. Cleavage: *b* distinct, *a* less so. Fracture: subconchoidal to uneven.

Composition: (Fe, Mn)Cb_2O_6, passing into tantalite (Fe, Mn)Ta_2O_6. Fe and Mn vary widely, Sn and W usually present. For $FeCb_2O_6$, Cb_2O_5 82.7, FeO 17.3, = 100. Where the Fe is largely replaced by Mn, the names manganocolumbite or manganotantalite are given.

Analyses: Mineral Hill, Middletown, Delaware County. Crystalline mass, iron black; brownish-black to reddish-brown on the surface. Sp. gr. 5.262–5.259. Genth, 1889, 52. A. Purest. B. Less pure.



78



79

Figs. 78–79. Columbite; 78, Boothwyn, Delaware County (*Smith*); 79, Mineral Hill, Delaware County (*Washington; Genth*).

	A	B
Cb_2O_5	76.26	76.64
Ta_2O_5	0.83	0.83
SnO_2	0.16	n.det.
ZrO_2	0.67	0.62
WO_3?	tr.	——
UO_3	0.18	0.18
Ce_2O_3, etc	0.34	0.48
Y_2O_3, etc	1.78	3.00
FeO	7.65	6.95
MnO	11.29	10.25
MgO	0.07	0.25
CaO	0.66	0.56
Ignition	0.33	n.det.
	100.22	99.76

LOCALITIES: *Chester County:* Nevin's quarry (London Britain); *Delaware County:* Avondale, Black Horse, Boothwyn (black prismatic crystals, 4×2 cm.), Mineral Hill (black prismatic crystals measuring 2.5–1.5 cm.), and Morton; *Philadelphia:* On Broad Street, at Duncannon Avenue, and at Olney Avenue.

SAMARSKITE

$R_4(Cb, Ta)_2O_7$ ORTHORHOMBIC

Color: velvet black. Streak: dark reddish-brown. Nearly opaque. Luster: vitreous to resinous, splendent. Form: flattened imbedded grains; rarely in rough crystals. Fracture: conchoidal. H = 5–6. Brittle. Sp. gr. 5.6–5.8.

Composition: $R_4(Cb, Ta)_2O_7$; R = $^1/_3$ (Y, Ce), $^1/_2$ (UO, ThO, Fe, Ca).

LOCALITIES: *Delaware County:* Boothwyn, and Mineral Hill.

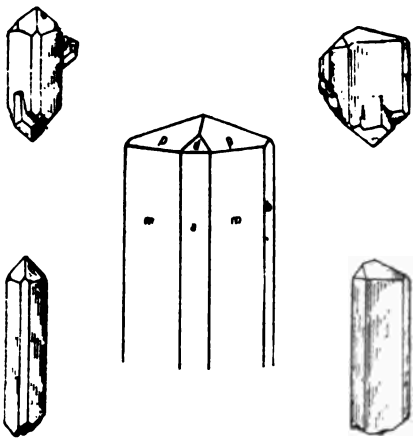
EUXENITE

$R_2(CbO_3)_3.R_2(TiO_3)_3.^3/_2H_2O$ ORTHORHOMBIC

Color: brownish-black. Streak: yellowish to reddish-brown. Nearly opaque. Luster:

brilliant, metallic, vitreous, or greasy. Form: massive; prismatic crystals. H = 6.5. Brittle. Sp. gr. 4.60–4.99.

Crystallography: Orthorhombic; a:b:c = 0.364 : 1 : 0.303.
$p_0:q_0:r_0$ = 0.8324 : 0.3030 : 1.



Figs. 80–84. Euxenite, Morton, Delaware County (*Law*).

Forms: *a* (100), *b* (010), *m* (110), *d* (201), and *p* (111); (Johnson's quarry).[84] Habit: prismatic. Cleavage none. Fracture: subconchoidal.

Composition: $R_2(CbO_3)_3.R_2(TiO_3)_3.{}^3/_2H_2O$; R = $^1/_3$(Y, Er), $^1/_3$(UO, ThO, Fe, Ca). Other rare earths, and germanium are present.

LOCALITY: *Delaware County:* Morton.

PHOSPHATES, ARSENATES, VANADATES, ETC.

XENOTIME	YPO_4	Tetragonal
MONAZITE	(Ce, La, Di)PO_4	Monoclinic
APATITE	(CaF)$Ca_4(PO_4)_3$ (CaCl)$Ca_4(PO_4)_3$	Hexagonal
PYROMORPHITE	(PbCl)$Pb_4(PO_4)_3$	Hexagonal
MIMETITE	(PbCl)$Pb_4(AsO_4)_3$	Hexagonal
VANADINITE	(PbCl)$Pb_4(VO_4)_3$	Hexagonal
LIBETHENITE	$Cu_2(OH)PO_4$	Orthorhombic
DESCLOIZITE	(Pb, Zn)$_2$(OH)VO_4	Orthorhombic
PSEUDOMALACHITE	$Cu_5(OH)_2PO_4$	
VIVIANITE	$Fe_3(PO_4)_2.8H_2O$	Monoclinic
ERYTHRITE	$Co_3(AsO_4)_2.8H_2O$	Monoclinic
SCORODITE	$FeAsO_4.2H_2O$	Orthorhombic
STRENGITE	$FePO_4.2H_2O$	Orthorhombic
WAVELLITE	$Al_3(OH, F)_3(PO_4)_2.5H_2O$	Orthorhombic
CERULEOLACTITE	$Al_6(OH)_6(PO_4)_4.7H_2O$	Orthorhombic
CACOXENITE	$Fe_4(OH)_6(PO_4)_2.9H_2O$	Monoclinic?
BERAUNITE	$Fe_6(OH)_6(PO_4)_4.5H_2O$	Monoclinic
TORBERNITE	$Cu(UO_2)_2(PO_4)_2.8H_2O$	Tetragonal
AUTUNITE	$Ca(UO_2)_2(PO_4)_2.8H_2O$	Orthorhombic
CARNOTITE	(Ca, K_2)$(UO_2)_2(VO_4)_2.3H_2O$	

[84] Law, 1907, 33–35.

XENOTIME

YPO_4 TETRAGONAL

Color: yellow or brown. Luster: resinous or vitreous. Opaque. Form: small tetragonal prismatic crystals resembling zircon. Brittle. H = 4–5. Sp. gr. 4.45–4.56.

Composition: YPO_4; Y_2O_3 61.4, P_2O_5 38.6, = 100. Y is replaced in part by Er; Ce may be present.

LOCALITIES: *Delaware County:* Boothwyn; *Philadelphia:* on Broad Street, at Duncannon Avenue, and at Olney Avenue. The above determinations were based on measurements of angles but the crystal faces were curved, and it is probable that the mineral listed above was cyrtolite.[85]

MONAZITE

$(Ce, La, Di)PO_4$ MONOCLINIC

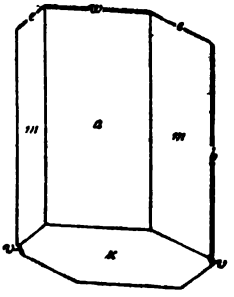
Color: red, yellowish- to reddish-brown. Subtransparent to subtranslucent. Luster: resinous. Form: prismatic or tabular crystals; rolled grains. H = 5–5.5. Brittle. Sp. gr. 4.9–5.3.

Crystallography: Monoclinic;

$a:b:c = 0.9693:1:0.9256$; $\beta = 103°40'$.

$p_0:q_0:r_0 = 0.9549:0.8994:1$; $\mu = 76°20'$.

Forms: *a* (100), *b* (010), *m* (110), *e* (011), *w* (101), *x* ($\bar{1}01$), and *v* ($\bar{1}11$) (Wherry, 1919, 123). Twins common; twin-plane *a*. Habit: tabular parallel to *a*, or prismatic. Cleavage: *c* (parting?), also *a*. Fracture: conchoidal, uneven.



85

Fig. 85. Monazite, Boothwyn, Delaware County (*Wherry*).

LOCALITIES: *Delaware County:* Boothwyn (brown, translucent crystals, often twinned, measuring up to 2.5×2.5×1 cm.), and Morgan Station.

APATITE

$(CaF)Ca_4(PO_4)_3$

$(CaCl)Ca_4(PO_4)_3$ HEXAGONAL

Color: green, blue, white, yellow, gray, red, brown. Streak: white. Transparent to opaque. Luster: vitreous, subresinous. Form: hexagonal prisms; columnar masses; granular. H = 5. Brittle. Sp. gr. 3.17–3.23.

Crystallography: Hexagonal; c = 1.2708; $p_0 = 0.8472$. Common forms: *m* ($10\bar{1}0$), *c* (0001), *p* ($10\bar{1}1$). Habit long or short prismatic; tabular. Cleavage: *c* and *m* imperfect. Fracture: conchoidal, uneven.

Composition: Fluor-apatite: $(CaF)Ca_4(PO_4)_3$; CaO 55.5, P_2O_5 42.3, F 3.8, = 101.6. Chlor-apatite: $(CaCl)Ca_4(PO_4)_3$; CaO 53.8, P_2O_5 41.0, Cl 6.8, = 101.6.

Synonyms: asparagus-stone, moroxite.

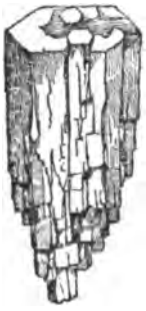
Analyses: A. McKinney's quarry, Germantown, Philadelphia. Light green, in pink

	A	B		C
P_2O_5	41.15	41.55		
F	3.35	1.95		
Cl	——	0.94		
CO_2	——	1.42		
CaO	54.15	53.97		
MgO	——	tr.		
FeO	——	0.73	$Ca_3P_2O_8$	89.74
Al_2O_3	0.10	——	$Fe_2P_2O_8$	1.14
Fe_2O_3	0.42	——	CaF_2	4.00
Na_2O	0.07	——	$CaCl_2$	1.57
K_2O	0.33	——	$CaCO_3$	3.22
SiO_2	——	0.25	Fe_2O_3	0.04
Insoluble	0.09	——	SiO_2	0.25
	99.66	100.81		99.96
Sp. gr.	3.165			

[85] Edgar T. Wherry, oral communication.

microcline. Eyerman, 1911, 18. B. London Grove, Chester County. Asparagus green, transparent prismatic crystals, externally coated with an opaque yellowish-white material. Carnot, 1896, 145. C. London Grove, Chester County, B recalculated. Carnot, 1896, 145; An old analysis by Seybert, 1821, 144, is omitted.

LOCALITIES: *Berks County:* Jones mine, and Ruth mine; *Bucks County:* Vanartsdalen's quarry; *Chester County:* Avondale (transparent green crystals and masses); south of Bailey's farm (East Marlboro), Black Horse, Brinton's quarry, Brown's quarry, Copesville, Corundum Hill, Doe Run quarries, Minorcus Hill, Nevin's quarry, and south of Phillips quarries; Sylmar; *Delaware County:* Adele, Avondale, Blue Hill, Boothwyn, Chelsea, Custer's farm (Darby), Green's farm (Chester), Franklin Paper Mills, Leiperville, Morgan Station, Morton, Strath Haven Inn, Trainer, and Ward's quarry; *Montgomery County:* Flat Rock tunnel, and Gladwyne; *Philadelphia:* Bustleton, Chestnut Hill, Cobb's Creek, Fairmount Park, Fox Chase, Frankford, Germantown, Holmesburg, Logan, Nicetown, O'Neill's quarry, Overbrook, Prince's quarry, Rittenhouse quarry (bluish-green, rough crystals up to 5 × 30 cm.), Shawmont, West Philadelphia, and Wissahickon Valley.



86

Fig. 86. Pyromorphite, Wheatley mines (*Dana*).

PYROMORPHITE

$(PbCl)Pb_4(PO_4)_3$ HEXAGONAL

Color: light green to dark olive-green; greenish-yellow; brown. Streak: white. Subtransparent to translucent. Luster: resinous. Form: hexagonal prisms, often barrel-shaped; parallel groups; acicular, globular, reniform, botryoidal; fibrous; granular. H = 3.5–4 Brittle. Sp. gr. 6.5–7.1, when pure; 5.9–6.5 when containing CaO.

Crystallography: Hexagonal; c = 1.275, p_0 = 0.8500. Forms: *c* (0001), *m* (10$\bar{1}$0), *a* (11$\bar{2}$0), *x* (10$\bar{1}$1), *y* (20$\bar{2}$1), *r* (40$\bar{4}$1), and *s* (11$\bar{2}$1). Cleavage: *m*, *x* in traces. Fracture: subconchoidal; uneven.

Composition: $(PbCl)Pb_4(PO_4)_3$; PbO 82.2, P_2O_5 15.7, Cl 2.6, = 100.5. P may be replaced by As, and Pb by Ca.

Analyses: A. Wheatley Mine, Chester County. Eyerman, 1911, 19. B. Wheatley Mine, Chester County. Green, granular. Genth, 1876, 228, analysis by Henry Pemberton, Jr.

	A		B
P_2O_5	15.19		
As_2O_5	tr.		
Cl	2.60	$Pb_3P_2O_8$	90.35
PbO	80.65	$PbCl_2$	9.11
CaO	0.11	Cr_2O_3	0.21
FeO	0.88	Al_2O_3, Fe_2O_3	0.55
Cr_2O_3	tr.	Quartz	0.25
	99.43		100.47
Sp. gr.	6.910	Sp. gr.	7.117

LOCALITIES: *Bucks County:* New Galena; *Chester County:* Charlestown mine, Morris mine, and Wheatley mines; *Montgomery County:* Ecton and Perkiomen mines, and Sumneytown; *Philadelphia:* Falls of Schuylkill.

MIMETITE

$(PbCl)Pb_4(AsO_4)_3$ HEXAGONAL

Colorless, pale yellow, orange-yellow. Streak: white. Subtransparent to translucent. Luster: resinous. Form: hexagonal prisms, acicular, sometimes globular or mammillary. H = 3.5. Brittle. Sp. gr. 7.0–7.25.

Crystallography: Hexagonal: c = 1.260, p_0 = 0.8400. Forms: *c* (0001), *m* (10$\bar{1}$0), *a* (11$\bar{2}$0), *x* (10$\bar{1}$1). Cleavage: *x* imperfect. Fracture uneven.

Composition: $(PbCl)Pb_4(AsO_4)_3$; PbO 74.9, As_2O_5 23.2, Cl 2.4, = 100.5. P may replace As, and Ca may replace Pb.

Analysis: Wheatley Mine, Chester County. Lemon-yellow. Smith, 1855, 248.

As_2O_5	23.17
P_2O_5	0.14
Cl	2.39
PbO	67.05
Pb	6.99
	99.74
Sp. gr.	7.32

LOCALITIES: *Chester County:* Wheatley mines; *Montgomery County:* Perkiomen mine.

VANADINITE

$(PbCl)Pb_4(VO_4)_3$ HEXAGONAL

Color: ruby-red, yellow and brown. Streak: white or yellowish. Luster: resinous. Subtranslucent to opaque. Form: hexagonal prismatic crystals, often in rounded forms or parallel groups; individual crystals are sometimes cavernous. H = 2.75–3. Sp. gr. 6.66–7.23.

Composition: PbO 78.7, Cl. 2.5, V_2O_5 19.4, = 100.

LOCALITY: *Chester County:* Wheatley mines.

LIBETHENITE

$Cu_2(OH)PO_4$ ORTHORHOMBIC

Color: dark olive-green. Translucent. Luster: resinous. Form: druses of minute crystals; also massive, reniform. H = 4. Sp. gr. 3.6–3.8.

Composition: CuO 66.4, P_2O_5 29.8, H_2O 3.8, = 100.

LOCALITY: *Montgomery County:* Perkiomen mine.

DESCLOIZITE

$(Pb, Zn)_2(OH)VO_4$ ORTHORHOMBIC

Color: cherry-red, brownish-red, or brown. Streak: orange, brownish-red, yellowish-gray. Transparent to nearly opaque. Luster: greasy. Form: drusy surfaces or stalactitic aggregations of minute prismatic or pyramidal crystals. H = 3.5. Brittle. Sp. gr. 5.9–6.2.

Composition: $(Pb, Zn)_2(OH)VO_4$; with Pb:Zn = 1:1, PbO 55.4, ZnO 19.7, V_2O_5 22.7, H_2O 2.2, = 100. Cu is sometimes present, and As may replace V.

Analysis: Wheatley mine, Chester County. Dark colored crystalline crusts on quartz and ferruginous clay with wulfenite. Imperfect analysis of a mixture. Smith, 1855, 247.

	A
V_2O_5	11.70
MoO_3	20.14
PbO	55.01
FeO, MnO, Al_2O_3	5.90
CuO	1.13
H_2O	2.94
Sand	2.21
	99.03

LOCALITY: *Chester County:* Wheatley mines: dark colored crystalline crusts of minute purple crystals.

PSEUDOMALACHITE

$Cu_5(OH)_4(PO_4)_2$ MONOCLINIC

Color: dark emerald-green, blackish-green. Streak: paler green. Luster: vitreous. Form: massive, reniform, botryoidal coatings with a radiating fibrous structure, H = 4.5–5. Sp. gr. 3.4–4.4.

Composition: $Cu_5(OH)_4(PO_4)_2$; CuO 69.0, P_2O_5 24.7, H_2O 6.3 = 100.

LOCALITIES: *Chester County:* Wheatley mines; *Montgomery County:* Ecton, and Perkiomen mines.

VIVIANITE

$Fe_3(PO_4)_2.8\,H_2O$ MONOCLINIC

Colorless when unaltered; blue or green on exposure. Streak: colorless to bluish-white, becoming indigo blue. Transparent to translucent; opaque after exposure. Luster: *b* pearly, elsewhere, vitreous. Form: prismatic crystals, often in stellate groups; fibrous, earthy, encrusting. H = 1.5–2. Sectile. Sp. gr. 2.58–2.68.

Crystallography: Monoclinic: $a : b : c = 0.7498 : 1 : 0.7017$; $\beta = 104°26'$.

$p_0 : q_0 : r_0 = 0.9358 : 0.6795 : 1$; $\mu = 75°34'$.

Forms: *a* (100), *b* (010), *m* (110), *y* (310), *n* (101), *x* (111), *s* (112), *r* ($\bar{1}12$), *w* ($\bar{1}01$), *v* ($\bar{1}11$). Habit: prismatic, prismatic faces vertically striated. Cleavage: *b* highly perfect; *a* in traces. Fracture: fibrous, nearly $\perp c$. Flexible in very thin laminae.

Composition: $Fe_3(PO_4)_2.8H_2O$; FeO 43.0, P_2O_5 28.3, H_2O 28.7, = 100. FeO is oxidized to Fe_2O_3 on exposure to light.

LOCALITY: *Lancaster County:* Gap nickel mine; colorless or greenish slender prismatic crystals.

ERYTHRITE

$Co_3(AsO_4)_2.8\,H_2O$ MONOCLINIC

Color: peach-red to crimson. Streak: paler. Transparent to subtranslucent. Luster: pearly, vitreous; dull, earthy. Form: pulverulent, incrusting; prismatic crystals; druses. H = 1.5–2.5. Sp. gr. 2.948.

Composition: $Co_3(AsO_4)_2.8H_2O$; CoO 37.5, As_2O_5 38.4, H_2O 24.1, = 100. Ni, Fe, or Ca may replace Co.

LOCALITIES: *Berks County:* Gickerville. *Chester County:* Wheatley mines, and French Creek mines.

SCORODITE

$FeAsO_4.2H_2O$ ORTHORHOMIC

Color: pale green to brown. Subtransparent to translucent. Luster: vitreous. Form: aggregates of crystals of octahedral habit; also earthy, incrusting. H = 3.5–4. Brittle. Sp. gr. 3.1–3.3.

Composition: Fe_2O_3 34.6, As_2O_5 49.8, H_2O 15.6, = 100.

LOCALITY: *Lancaster County:* Gap nickel mine.

STRENGITE

$FePO_4.2H_2O$ ORTHORHOMBIC

Colorless, yellow; peach-blossom red. Streak: yellowish-white. Translucent to transparent. Form: spherical or botryoidal aggregates with radiating fibrous structure and drusy surface; rarely in distinct crystals. H = 3–4. Sp. gr. 2.87.

Composition: $FePO_4.2\,H_2O$; Fe_2O_3 42.7, P_2O_5 38.0, H_2O 19.3, = 100.

LOCALITIES: *Cumberland County:* Moore's Mill; *Lancaster County:* Beartown.

WAVELLITE

$Al_3(OH, F)_3(PO_4)_2.5H_2O$ ORTHORHOMBIC

Colorless, white, yellow, green. Streak: white. Transparent to translucent. Luster: vitreous, pearly, or resinous. Form: minute prismatic crystals, usually in radiating aggregates or druses; hemispherical or globular aggregates with a radiating structure and crystalline surface. H = 3.25–4. Brittle. Sp. gr. 2.337, 2.316.

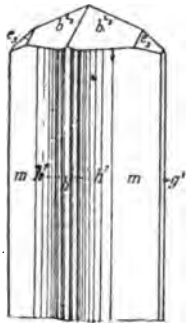
Crystallography: Orthorhombic;[86] $a : b : c = 0.5520 : 1 : 0.4067$.

$p_0 : q_0 : r_0 = 0.7365 : 0.4067 : 1$.

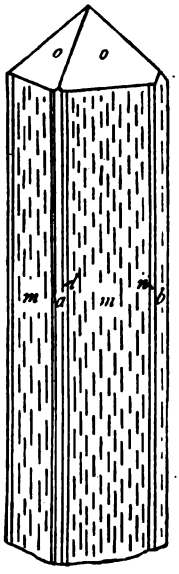
[86] Ungemach gave for Moore's Mill, Cumberland County; and Wherry, for Hellertown, Northampton County:

$a : b : c = 0.5577 : 1 : 0.4057$ (Ungemach).
$a : b : c = 0.5640 : 1 : 0.4040$ (Wherry).

Forms: *a* (100), *b* (010), *m* (110), *l* (430), *n* (340), *v* (320), *h* (310), *s* (101), *p* (111), *o* (121)
Habit: prismatic. Cleavage: *p* and *b* perfect. Fracture: uneven, subconchoidal.



87



88

Fig. 87. Wavellite, Moore's Mill, Cumberland County (*Ungemach*).
Fig. 88. Wavellite, Hellertown, Northampton County (*Wherry*).

Analyses: A. General Trimble's mine, East Whiteland, Chester County. Genth, 1857, 423. Stalactitic variety. B. General Trimble's mine, Chester County. Less pure variety. Hermann, 1869, 496. C. Hellertown, Northampton County. Acicular crystals on sandstone. Wherry, 1918, 380, analysis by Frederick Wynkoop. F too low. $\alpha = 1.525$, $\beta = 1.535$, $\gamma = 1.550$, all ± 0.005. D. Jacob Stine's farm, 2 miles south of Macungie, Lehigh County. White, colorless radiations on limonite. Smith and Thomas, 1882, 231. E-F. Jacob Stine's farm, Upper Milford, Lehigh County. Nodular clay-like forms accompanying the wavellite: E. Light variety. F. Dark variety. Smith, 1883, 274.

	A	B	C	D	E	F
P_2O_5	34.68	32.70	33.4	34.14	19.19	22.52
F	tr.	tr.	0.8	tr.	——	——
Al_2O_3	36.67	35.83	36.5	36.66	23.19	29.37
Fe_2O_3	——	3.08	——	——	3.82	15.61
MgO, CaO	——	——	——	——	1.47	——
SiO_2	——	——	——	——	32.42	6.52
H_2O	28.29	28.39	28.6	28.32	19.37	26.29
Impurities	0.22	——	1.1	0.60	——	——
	99.86	100.00	100.4	99.72	99.46	100.31
Less O = F			0.3			
Total			100.1			
Sp. gr		2.30	2.325		2.5	2.40

Localities: *Berks County:* Blandon; *Chester County:* General Trimble's mine (East Whiteland); *Cumberland County:* Moore's Mill (nodular; white radiations; colorless crystals

measuring 1 mm. in diameter); *Huntingdon County:* Sandy Ridge near Orbisonia; *Juniata County:* Ross farm (green, radiating nodules on Oriskany sandstone); *Lancaster County:* Chestnut Hill; *Lehigh County:* Macungie; *Northampton County:* Hellertown (small acicular crystals in divergent groups); *Perry County:* New Bloomfield (minute crystals in *Gypidula galeata*). *York County:* Peachbottom (small grayish-white spherical and radiating aggregates).

CERULEOLACTITE

$Al_6(OH)_6(PO_4)_4.7H_2O$ ORTHORHOMBIC

Color: white to light-blue. Streak white. Translucent. Luster: vitreous. Form: botryoidal aggregates of microscopic crystals of tabular habit in parallel position. H = 5. Sp. gr. 2.552–2.593.

Composition: $Al_6(OH)_6(PO_4)_4.7H_2O$; Al_2O_3 39.7, P_2O_5 36.9, H_2O 23.4, = 100. F probably replaces (OH), this would account for the high summation in Genth's analysis.

Analysis: General Trimble's mine, East Whiteland, Chester County. Pale bluish, greenish-blue to sky-blue, cryptocrystalline, botryoidal coatings. Genth, 1875, 143. B. Calculated from the analysis.

	A	B
P_2O_5	36.31	37.04
Al_2O_3	38.27	39.34
CuO	4.25	——
H_2O	21.70	23.62
Insoluble	0.54	——
	101.07	100.00

LOCALITY: *Chester County:* General Trimble's mine (East Whiteland).

BERAUNITE

$Fe_6(OH)_6(PO_4)_4.5H_2O$ MONOCLINIC

Color: reddish-brown to dark hyacinth-red. Streak: yellow. Translucent. Luster: vitreous; pearly. Form: druses of minute crystals; fibrous, radiating crusts or globules. H = 2. Sp. gr. 2.85–2.98.

Optical Properties:[87] Beraunite from Hellertown: α and β = 1.78, γ = 1.81; Extinction straight; elongation parallel to b,–.

Composition. $Fe_6(OH)_6(PO_4)_4.5H_2O$; Fe_2O_3 52.8, P_2O_5 31.3, H_2O 15.9, = 100.

Analyses: Hellertown, Northampton County. Deep brown nodular crusts and flat radiations. Wherry, 1915, 508. A. by J. S. Long; B. by Louis H. Koch; C–D. by Wherry; E. average; F. recalculated analysis. Sp. gr. 2.850–2.920.

	A	B	C	D	E	F
P_2O_5	28.10	29.27	28.53	27.43	28.33	28.71
Fe_2O_3	42.91	52.65	55.61	57.80	57.89	58.69
Mn_2O_3	15.25	3.88	1.80	1.66		
SiO_2	4.02	0.71	0.34	0.55	1.41	——
H_2O	10.01	13.59	13.54	12.60	12.43	12.60
	100.29	100.10	99.82	100.04	100.06	100.00

LOCALITIES: *Cumberland County:* Moore's Mill, druses of bright red crystals; *Northampton County:* Hellertown, brown nodular crusts and flat radiations measuring 1 cm.

CACOXENITE

$Fe_4(OH)_6(PO_4)_2.9H_2O$ MONOCLINIC?

Color: golden-yellow, brownish-yellow. Streak: ochre-yellow. Translucent. Luster: silky. Form: radiating tufts of minute prismatic or acicular crystals. H = 3–4. Sp. gr. 2.4; 3.38.

Composition: $Fe_4(OH)_6(PO_4)_2.9H_2O$; Fe_2O_3 47.2, P_2O_5 20.9, H_2O 31.9, = 100.

[87] Wherry, 1915, 507.

LOCALITIES: *Cumberland County:* Moore's Mill (golden yellow aggregates of acicular crystals; with beraunite and strengite); *Lancaster County:* Beartown, and Chestnut Hill; *Montgomery County:* Spring Mill; *Northampton County:* Hellertown.

TORBERNITE

$Cu(UO_2)_2(PO_4)_2.8H_2O$ TETRAGONAL

Color: leek-green to emerald-green. Streak: paler. Transparent to subtranslucent. Luster: of *c* pearly, other faces subadamantine. Form: square tabular crystals, very thin plates, foliated, micaceous. Cleavage: *c* perfect. H = 2–2.5. Laminae brittle. Sp. gr. 3.4–3.6.

Composition. $Cu(UO_2)_2(PO_4)_2.8H_2O$; CuO 8.4, UO_3 61.2, P_2O_5 15.1, H_2O 15.3, = 100.

LOCALITIES: *Berks County:* Trexler mica mine (Alsace); *Carbon County:* Mauch Chunk? *Delaware County:* Avondale, Crozer's quarry in Chester, and Leiperville; *Montgomery County:* Edge Hill? and Wyncote; *Philadelphia:* Comley's quarry (Mt. Airy), Fairmount Park opposite the old Fairmount Water Works, Frankford, McCrea's quarry (Mt. Airy), and Penn Street quarry (Germantown).

AUTUNITE

$Ca(UO_2)_2(PO_4)_2.8H_2O$ ORTHORHOMBIC

Color: lemon- to sulphur-yellow. Streak: yellowish. Transparent to translucent. Luster: *c* pearly, other faces subadamantine. Form: thin tabular crystals, nearly square in form, foliated aggregates with micaceous structure. Cleavage: *c* eminent. H = 2–2.5. Laminae brittle. Sp. gr. 3.05–3.19.

Composition: $Ca(UO_2)_2(PO_4)_2.8H_2O$; CaO 6.1, UO_3 62.7, P_2O_5 15.5, H_2O 15.7, = 100.

LOCALITIES: *Berks County:* Trexler mica mine (Alsace); *Delaware County:* Avondale, Bunting's quarry (Bethel), Crozer's quarry in Chester, Dickinson's Mill (Haverford), and Leiperville; *Philadelphia:* Broad Street and Olney Avenue, Fairmount Park, and McCrea's quarry (Mt. Airy).

CARNOTITE

$(K_2, Ca)\ (UO_2)_2(VO_4)_2.3H_2O$ ORTHORHOMBIC

Color: yellow. Opaque. Luster: earthy. Form: amorphous to minutely crystalline coatings or impregnations.

Analyses: Mauch Chunk, Carbon County. Bright yellow amorphous to minutely crystalline coatings and impregnations. A. Wherry, 1914, 149; B. Recalculated; C. Wherry, 1912, 574, analysis by J. S. Long.

	A	B	C
V_2O_5	9.80	21.73	7.2
UO_3	31.11	68.99	23.8
K_2O	3.55	7.86	(1.6) diff.
CaO	0.64	1.42	1.5
Fe_2O_3	17.68	——	6.1
H_2O	7.13	——	10.5
Insoluble	29.62	——	49.3
	99.53	100.00	100.0

LOCALITY: *Carbon County:* Mauch Chunk, yellow streaks and patches in Pottsville conglomerate.

ANTIMONATE

BINDHEIMITE		Amorphous

NITRATES

NITER	KNO_3	Orthorhombic
NITRICALCITE	$Ca(NO_3)_2.nH_2O$	

URANATES

URANINITE	UO_3 of UO_2, ThO_2, etc.	Isometric
GUMMITE	$(Pb, Ca, Ba)U_3SiO_{12}.5H_2O$	Amorphous

BINDHEIMITE

Color: yellow. Luster: usually dull or earthy; also resinous. Opaque to translucent. Form: earthy, incrusting. H = 4. Sp. gr. 4.60–4.76.

Composition: a hydrous antimonate of lead, probably a colloid.

LOCALITY: *Delaware County:* Morton?[88]

NITER

KNO_3 ORTHORHOMBIC

Color and streak: white. Subtransparent. Luster: vitreous. Form: thin crusts, silky tufts, of delicate acicular crystals. H = 2. Brittle. Sp. gr. 2.09–2.14.

Composition: KNO_3; K_2O 46.5, N_2O_5 53.5, = 100.

LOCALITY: *Tioga County:* occurs locally as an efflorescence on Pocono sandstone.

NITROCALCITE

$Ca(NO_3)_2$, nH_2O

Color: white or gray. Form: efflorescent silky tufts and masses. Taste sharp and bitter.

LOCALITIES: *Chester County:* McNeal's quarry (Doe Run); *York County:* York, and York Valley.

URANINITE

UO_3, UO_2, THO_2, PbO, etc. ISOMETRIC

Color: velvet-black, brownish. Streak: brownish-black, olive-green. Opaque. Luster: submetallic, to greasy, or pitch-like. Form: octahedra, cubo-octahedra; massive, imbedded grains, often with an envelope of gummite. Fracture: conchoidal to uneven. H = 5.5. Brittle. Sp. gr. 9.0–9.9, crystals; massive altered varieties: 6.4 and upward.

Composition: The mineral is considerably altered through radioactive decay, and quite frequently in addition by weathering. UO_3, UO_2, ThO_2, PbO, He, metals of the La and Yt groups, Ca, Fe and H_2O are usually present.

LOCALITIES: *Delaware County:* Avondale, Crozer's quarry in Chester, near Franklin Paper Mills, and Green's farm near Upland; *Lehigh County:* Vera Cruz; *Philadelphia:* Fairmount Park opposite the old Fairmount Water Works.

GUMMITE

(Pb, Ca)U_3SiO_{12}.$5H_2O$ AMORPHOUS

Color: reddish-yellow, orange, red, reddish-brown. Streak: yellow. Feebly translucent. Luster: greasy. Form: rounded or flattened masses, an alteration product of uraninite, and frequently containing an unaltered core of the latter. H = 2.5–3. Sp. gr. 3.9–4.20.

LOCALITIES: *Delaware County:* Avondale, Crozer's quarry, Dickinson's Mill (Haverford), near Franklin Paper Mills, and Leiperville; *Philadelphia:* Fairmount Park opposite the old Fairmount Water Works, and McCrea's quarry (Mt. Airy).

SULFATES

GLAUBERITE	$Na_2Ca(SO_4)_2$	Monoclinic
BARITE	$BaSO_4$	Orthorhombic
CELESTITE	$SrSO_4$	Orthorhombic
ANGLESITE	$PbSO_4$	Orthorhombic
ANHYDRITE	$CaSO_4$	Orthorhombic
VAUQUELINITE	$2(Pb, Cu)CrO_4.(Pb, Cu)_3(PO_4)_2$	Monoclinic
BROCHANTITE	$Cu_4(OH)_6SO_4$	Orthorhombic
MIRABILITE	$Na_2SO_4.10H_2O$	Monoclinic
GYPSUM	$CaSO_4.2H_2O$	Monoclinic
EPSOMITE	$MgSO_4.7H_2O$	Orthorhombic
GOSLARITE	$ZnSO_4.7H_2O$	Orthorhombic
MORENOSITE	$NiSO_4.7H_2O$	Orthorhombic

[88] Further study of this material indicated the principal constituent to be bismuth and it probably represents an impure alteration product of bismuthinite. Edgar T. Wherry, oral communication.

MELANTERITE	$FeSO_4.7H_2O$	Monoclinic
BIEBERITE	$CoSO_4.7H_2O$	Monoclinic
CHALCANTHITE	$CuSO_4.5H_2O$	Triclinic
KALINITE	$KAl(SO_4)_2.12H_2O$	Isometric
HALOTRICHITE	$FeAl_2(SO_4)_4.24H_2O$	Monoclinic
ALUNOGEN	$Al_2(SO_4)_3.12H_2O$	Monoclinic
LANGITE	$Cu_4(OH)_6SO_4.H_2O$	Orthorhombric
COPIAPITE	$Fe_4(OH)_2(SO_4)_5.17H_2O$	Monoclinic
GLOCKERITE	xFe_2O_3, ySO_3, zH_2O (II III)	Amorphous
BOTRYOGEN	$MgFeFe_2S_4O_{17}.18H_2O$	Monoclinic
URACONITE		

GLAUBERITE

$Na_2Ca(SO_4)_2$ MONOCLINIC

Color: pale yellow or gray. Luster: vitreous. Form: pyramidal or prismatic crystals. H = 2.5–3. Brittle. Sp. gr. 2.7–2.85.

Crystallography: Monoclinic; $a : b : c = 1.2199 : 1 : 1.0275$; $\beta = 112°11'$

$p_0 : q_0 : r_0 = 0.8423 : 0.9514 : 1$; $\mu = 67°49'$

Forms: *a* (100), *c* (001), *m* (110), *s*(111). Cleavage: *c* perfect.

Composition: $Na_2Ca(SO_4)_2$; CaO 20.1, Na_2O 22.3, SO_3 57.6, = 100.

LOCALITIES: The mineral is only known in Pennsylvania as crystal cavities from which the glauberite has been leached, and as casts, in the Triassic shales at the following localities: *Adams County:* Bermudian Churches, Goldenville, and Mummasburg; *Bucks County:* Mt. Eyre, and Steinsburg.

BARITE

$BaSO_4$ ORTHORHOMBIC

Colorless, white, yellow, gray, blue, red, brown. Streak: white. Transparent to opaque. Luster: vitreous, inclining to resinous. Form: tabular or prismatic crystals; fibrous, laminated, or granular masses. H = 2.5–3.5. Brittle. Sp. gr. 4.3–4.6.

Crystallography: Orthorhombic; $a : b : c = 0.8152 : 1 : 1.3136$.

$p_0 : q_0 : r_0 = 1.6114 : 1.3136 : 1$.

Common forms: *c* (001), *m* (110), *d* (102), *o* (011). Habit: tabular parallel to *c*, prismatic parallel to the b or c axis. Cleavage: *c*, *m*, perfect; *b* imperfect. Fracture: uneven.

Composition: $BaSO_4$; BaO 65.7, SO_3 34.3, = 100.

Analyses: McCreath, 1879, 369. A–B. Silas Locke's farm, 1/2 mile northeast of Fort Littleton, Fulton County. Bluish-gray, massive granular. C. Col. Galbraith's farm, Sinking Valley, Blair County. Reddish-gray. D–E. Christian Shockey's farm, 2 1/2 miles south of Waynesboro, Franklin County. White to bluish-gray, granular and columnar radiating masses.

	A	B	C	D	E
$BaSO_4$	95.22	96.91	97.08	95.91	98.65
$SrSO_4$	none	none	none	none	none
Al_2O_3, Fe_2O_3	0.38	0.31	0.76	0.24	0.14
MnO	0.05	——	——	——	——
CaO	0.59	tr.	——	0.17	tr.
MgO	0.18	tr.	tr.	0.11	tr.
CO_2	0.65	——	——	——	——
H_2O	0.23	0.08	0.32	0.09	0.20
SiO_2	2.45	2.35	1.74	2.80	1.11
	99.75	99.65	99.90	99.32	100.10

LOCALITIES: *Beaver County:* New Brighton; *Bedford County:* Bridgeport; *Berks County:* Bernville, Mt. Etna, and Heidelberg township (brownish, fetid, columnar and radiating masses); *Blair County:* Sinking Valley; *Bucks County:* Buckingham, Buckmanville, Bushington, and Fin-

ney's quarry; *Chester County:* Jug Hollow mine, Morris mine, and Wheatley mines; *Franklin County:* Guilford Springs, Knepper, Lancaster Station, Roadside, and Waynesboro; *Fulton County:* Fort Littleton; *Huntingdon County:* Broad Top Mountain, and Sandy Ridge near Orbisonia; *Montgomery County:* Ecton and Perkiomen mines, Marble Hall, and Mogeetown; *Northampton County:* Chestnut Hill; *Philadelphia:* Prince's quarry; *York County:* York Valley.

CELESTITE

$SrSO_4$ ORTHORHOMBIC

Color: white, light blue, red. Streak: white. Transparent to subtranslucent. Luster: vitreous, sometimes pearly. Form: fibrous masses, radiated, granular; tabular or prismatic crystals. H = 3–3.5. Sp. gr. 3.95–3.97.

Crystallography: Orthorhombic; a : b : c = 0.7811 : 1 : 1.2830.

$p_0 : q_0 : r_0 = 1.6426 : 1.2830 : 1.$

Common forms: *a* (100), *b* (010), *c* (001), *m* (110), *d* (101), and *o* (011). Cleavage: *c* perfect, *m* less so, *b* distinct.

Composition; $SrSO_4$; SrO 56.4, SO_3 43.6, = 100.

Analysis: Bellwood, Blair County. Pale grayish-blue, fibrous. Klaproth, 1797, 92. The analysis is here inserted because of its historic interest.

Strontia	42
Sulphuric acid	58
	100

LOCALITY: *Blair County:* Bellwood[89] (pale blue fibrous layers); and Williamsburg (faintly bluish crystals measuring 2 cm. in length); *Northampton County:* Chestnut Hill?

ANGLESITE

$PbSO_4$ ORTHORHOMBIC

Colorless, white, yellowish, gray, green-blue. Streak: uncolored. Transparent to opaque. Luster: adamantine, resinous, or vitreous. Form: prismatic or tabular crystals; massive, granular. H = 2.75–3. Brittle. Sp. gr. 6.12–6.39.

Crystallography: Orthorhombic; a : b : c = 0.7852 : 1 : 1.2894.

$p_0 : q_0 : r_0 = 1.6421 : 1.2894 : 1.$

Forms: *a* (100), *b* (010), *c* (001); *m*, M (110), *n* (120), *d* (102), *l* (104), *o* (011), *s* (111), *r* (112), *v* (212), *t* (121), *y* (122), *p* (324), χ (441), Wheatley mines.[90] Habit: prismatic, tabular parallel to *c*, or pyramidal. Faces *m*, and *a* often vertically striated, *d* horizontally. Cleavage: *c* distinct. Fracture: conchoidal.

Composition: $PbSO_4$; PbO 73.6, SO_3 26.4, = 100.

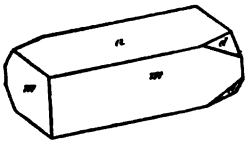
Analysis: Wheatley mine, Chester County. Colorless, transparent crystals. Sp. gr. 6.35. Smith, 1855, 244.

	A	B
SO_3	26.78	26.61
PbO	73.31	73.22
SiO_2	0.20	——
	100.29	98.83

LOCALITIES: *Chester County:* Wheatley mines (colorless, occasionally black, green or yellow; pyramidal, tabular, or prismatic crystals up to half pound in weight, and measuring 13.5 × 3.5 cm., in cavities in galena, with limonite, and often sulfur and copper); *Lancaster County:* Pequa mines; *Montgomery County:* Ecton and Perkiomen mines.

[89] Bellwood is the *type locality* for celestite. The mineral was collected by a German traveller, Schütz, in 1791. The analysis quoted above was made by Klaproth from this material, who found in it the then newly discovered element strontium. Werner named the mineral "Coelestin" because of the faintly blue color of the mineral.

[90] Smith, 1855, 244; Dana, 1854, 420; Lang, 1859, 282, 286, and 292; Dufrenoy, 1856, plate 103, fig. 313.



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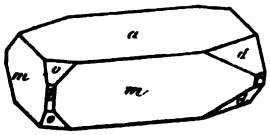

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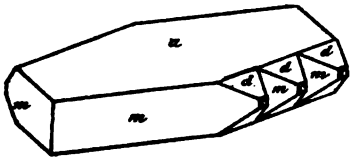

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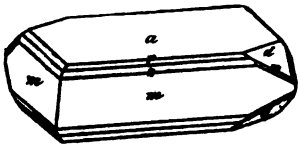
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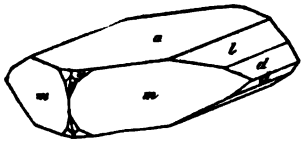

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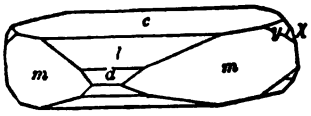

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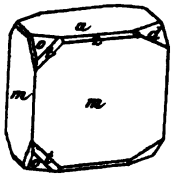

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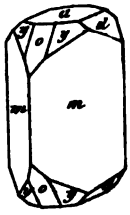

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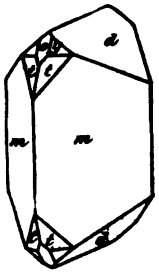

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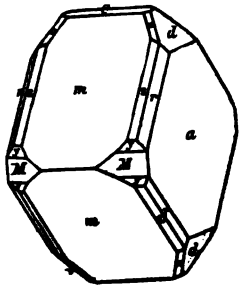

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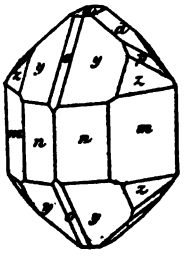

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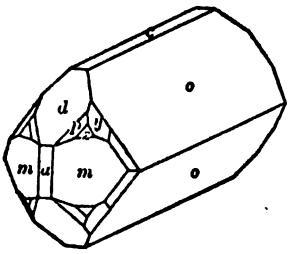
Figs. 89–99. Anglesite, Wheatley mines (89–93, 95–97, 99, *Lang;* 98, *Schrauf;* 94, *Dana*).



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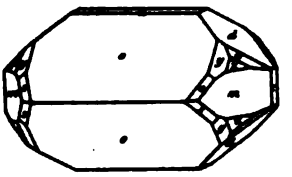

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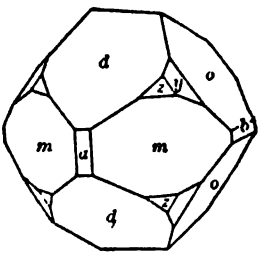

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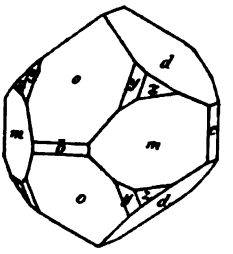

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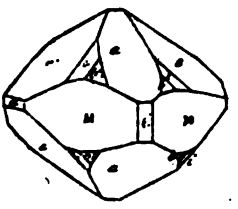

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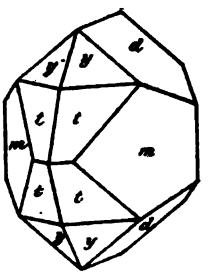

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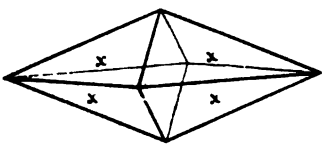

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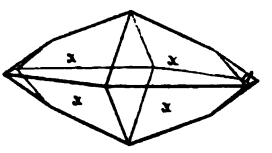

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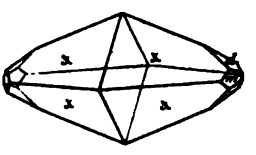


108

Figs. 100–108. Anglesite, Wheatley mines; (103, 105–107, *Lang;* 101, *Schrauf;* 104, *Dufrenoy;* 100, 102, *Dana*).

ANHYDRITE

$CaSO_4$ ORTHORHOMBIC

Color: white, grayish, bluish, or reddish. Streak: grayish-white; Luster: *c* pearly, *a* greasy, and *b* vitreous. Transparent to translucent. Form: cleavage masses; granular, fibrous, or lamellar; rarely in tabular crystals. Cleavage: parallel to the three pinacoids, perfect. H = 3–3.5. Sp. gr. 2.90–2.98.

Composition: $CaSO_4$; CaO 41.2, SO_3 58.8, = 100.

LOCALITY: *Blair County:* Bellwood.

VAUQUELINITE

$2(Pb, Cu)CrO_4.(Pb, Cu)_3(PO_4)_2$ MONOCLINIC

Color: green or brownish. Luster: adamantine to resinous. Faintly translucent to opaque. Form: minute wedge-shaped crystals, usually in mammillary or botryoidal aggregates. H = 2.5–3. Sp. gr. 5.8–6.1.

Composition: PbO 69.5, CuO 4.9, CrO_3 15.0, P_2O_5 10.6, = 100.

LOCALITY: *Lancaster County:* Pequa mines? (minute green crystals with acute terminations, in radiating aggregates on quartz and galena).

BROCHANTITE

$Cu_4(OH)_6SO_4$ ORTHORHOMBIC

Color: emerald or blackish-green. Streak: pale green. Transparent to translucent. Luster: vitreous. Form: acicular crystals, drusy crusts, massive, reniform. H = 3.5–4. Sp. gr. 3.907.

Composition: $Cu_4(OH)_6SO_4$; CuO 70.3, SO_3, 17.7, H_2O 12.0, = 100.

LOCALITY: *Lebanon County:* Cornwall; dark emerald-green or blackish-green acicular crystals and druses.

MIRABILITE

$Na_2SO_4.10H_2O$ MONOCLINIC

Color: white. Transparent to opaque. Luster: vitreous. Form: efflorescent crusts. Taste cool, then feebly saline and bitter. H = 1.5–2. Sp. gr. 1.481.

Composition: $Na_2SO_4.10H_2O$; Na_2O 19.3, SO_3 24.8, H_2O 55.9, = 100.

LOCALITIES: Occurs as efflorescences on Wissahickon gneiss in *Delaware County:* Chester; and *Philadelphia:* West Philadelphia.[91]

GYPSUM

$CaSO_4.2H_2O$ MONOCLINIC

Colorless, white, gray, yellow, blue. Streak: white. Transparent to opaque. Luster: *b* pearly, other faces subvitreous. Form: prismatic or acicular crystals, often radiating; lamellar or granular masses. H = 1.5–2. Sp. gr. 2.314–2.328.

Crystallography: Monoclinic; $a:b:c = 0.6895:1:0.4133$; $\beta = 98°58'$.

$p_0:q_0:r_0 = 0.5994:0.4083:1$; $\mu = 81°02'$.

Common forms: *m* (110), *b* (010), *l* (111), *n* ($\bar{1}11$). Twins common, twin-plane *a*, contact twins. Habit: flattened parallel to *b*, prismatic or acicular parallel to the c axis. Cleavage: *b* eminent; also *a*, *n*, and *t* ($\bar{1}01$).

Composition: $CaSO_4.2H_2O$; CaO 32.5, SO_3 46.6, H_2O 20.9, = 100.

Synonym: selenite.

LOCALITIES: *Berks County:* Jones mine, and North Reading; *Bucks County:* Finney's quarry, and Vanartsdalen's quarry; *Chester County:* French Creek mines, and Wheatley mines; *Delaware County:* Darby; *Lebanon County:* Cornwall (acicular crystals, often enclosing copper); *Northampton County:* Chestnut Hill; *York County:* Spring Grove, and York Valley.

EPSOMITE

$MgSO_4.7H_2O$ ORTHORHOMBIC

Color and streak: white. Transparent to translucent. Luster: vitreous. Form:

[91] It is probable that this occurrence of mirabilite was due to blasting powder.

acicular crystals; fibrous crusts; botryoidal masses. Taste bitter and saline. H = 2.0–2.5. Sp. gr. 1.75.

Composition: $MgSO_4.7H_2O$; MgO 16.3, SO_3 32.5, H_2O 51.2, = 100.

LOCALITIES: *Huntingdon County:* Sideling Hill tunnel: *Montgomery County:* Rose's quarry; *Philadelphia:* Fairmount Park, and Prince's quarry; *Westmoreland County:* Saltsburg.

GOSLARITE

$ZnSO_4.7H_2O$ ORTHORHOMBIC

Color: white, yellowish, bluish, reddish. Transparent to translucent. Luster: vitreous. Form: commonly massive; long acicular crystals. Taste: astringent, metallic, and nauseous. H = 2–2.5. Sp. gr. 1.9–2.1.

Composition: $ZnSO_4.7H_2O$; ZnO 28.2, SO_3 27.9, H_2O 43.9, = 100. Fe may replace Zn.

LOCALITY: *Lehigh County:* Friedensville.

MORENOSITE

$NiSO_4.7H_2O$ ORTHORHOMBIC

Color: apple-green to greenish-white. Streak: white. Luster: vitreous. Form: acicular crystals, fibrous, occurring as efflorescent masses. Taste: metallic astringent. H = 2–2.5. Sp. gr. 2.004.

Composition: $NiSO_4.7H_2O$; NiO 26.6, SO_3 28.5, H_2O 44.9, = 100.

LOCALITY: *Lancaster County:* Gap nickel mine.

MELANTERITE

$FeSO_4.7H_2O$ MONOCLINIC

Color: various shades of green to white, yellow on exposure. Streak: uncolored. Subtransparent to translucent. Luster: vitreous. Form: fibrous, stalactitic, massive, pulverulent, incrusting. Taste: sweet, astringent, and metallic. H = 2. Brittle. Sp. gr. 1.89–1.90.

Composition: $FeSO_4.7H_2O$; FeO 25.9, SO_3 28.8, H_2O 45.3, = 100.

LOCALITY: *Lancaster County:* Gap nickel mine.

BIEBERITE

$CoSO_4.7H_2O$ MONOCLINIC

Color: flesh- to rose-red. Subtransparent to translucent. Luster: vitreous. Form: stalactitic crusts. Fragile. Taste astringent. Sp. gr. 1.924.

Composition: $CoSO_4.7H_2O$; CoO 26.6, SO_3 28.5, H_2O 44.9, = 100.

LOCALITY: *Lebanon County:* Cornwall; flesh-colored coatings on magnetite.

CHALCANTHITE

$CuSO_4.5H_2O$ TRICLINIC

Color: deep blue, greenish-blue. Streak: uncolored. Subtransparent to translucent. Luster: vitreous. Form: massive, stalactitic, incrusting. Fracture: conchoidal. Taste metallic, nauseous. H = 2.5. Brittle. Sp. gr. 2.12–2.30.

Composition: $CuSO_4.5H_2O$; CuO 31.8, SO_3 32.1, H_2O 36.1, = 100.

LOCALITIES: *Chester County:* Wheatley mines? *Lancaster County:* Gap nickel mines; *Montgomery County:* Rose's quarry; *Philadelphia:* Prince's quarry.

KALINITE

$KAl(SO_4)_2.12H_2O$ ISOMETRIC

Color: white. Transparent to translucent. Luster: vitreous. Form: fibrous, massive, or mealy crusts. H = 2–2.5. Sp. gr. 1.75.

Composition: $KAl(SO_4)_2.12H_2O$; K_2O 9.9, Al_2O_3 10.8, SO_3 33.7, H_2O 45.6, = 100.

LOCALITIES: *Delaware County:* Chester?; *Lancaster County:* Cully Station.

HALOTRICHITE

$FeAl_2(SO_4)_4.24H_2O$ MONOCLINIC

Color: yellowish-white. Translucent. Luster: silky. Form: silky-fibrous, incrusting; becomes dull and pulverulent on exposure. Taste: inky, astringent. Sp. gr. 1.88–2.04.

Composition: $FeAl_2(SO_4)_4.24H_2O$; FeO 7.8, Al_2O_3 11.0, SO_3 34.5, H_2O 46.7, = 100.

LOCALITIES: *Carbon County:* Lansford; *Chester County:* Coventryville; *Montgomery County:* Harpers Station, and Pencoyd; *Philadelphia:* Fairmount Park, Falls of Schuylkill, Hestonville, and Wissahickon Valley.

ALUNOGEN

$Al_2(SO_4)_3.18H_2O$ MONOCLINIC

Color: white, or yellowish. Subtranslucent to transparent. Luster: vitreous or silky. Form: delicate fibrous masses or crusts. Taste like that of alum. H = 1.5–2. Sp. gr. 1.6–1.8.

Composition: $Al_2(SO_4)_3.18H_2O$; Al_2O_3 15.3, SO_3 36.0, H_2O 48.7, = 100.

Analysis: School Lane and Ridge Avenue, Falls of Schuylkill, Philadelphia. Eyerman, 1911, 21.

SO_3	36.11
Al_2O_3	15.71
FeO	2.59
H_2O	45.00
	99.41

LOCALITIES: *Allegheny County:* Pittsburgh; *Philadelphia:* Fairmount Park, Falls of Schuylkill, Hestonville, and Wissahickon Valley; *Schuylkill County:* Mahanoy City.

LANGITE

$Cu_4(OH)_6SO_4.H_2O$ ORTHORHOMBIC

Color: blue or greenish-blue. Luster: vitreous or silky. Translucent. Form: fibrous or lamellar crusts; minute prismatic crystals. H = 2.5–3. Sp. gr. 3.48–3.50.

Composition: CuO 67.6, SO_3 17.0, H_2O 15.3, = 100.

LOCALITY: *Lebanon County:* Cornwall, small bluish-green crystals.

COPIAPITE

$Fe_4(OH)_2(SO_4)_5.17H_2O$ MONOCLINIC

Color: sulfur-yellow, citron-yellow. Translucent. Luster: Pearly. Form: granular masses, pseudo-hexagonal scales, incrusting. Taste: astringent, nauseous. H = 2.5. Sp. gr. 2.103.

Composition: $Fe_4(OH)_2(SO_4)_5.17H_2O$; Fe_2O_3 30.6, SO_3 38.3, H_2O 31.1, = 100.

LOCALITIES: *Lancaster County:* Gap nickel mine; *Schuylkill County:* Mahanoy City: yellow pulverulent masses.

GLOCKERITE

xFe_2O_3, ySO_3, zH_2O AMORPHOUS

Color: ochre-yellow, brown. Opaque to subtranslucent. Luster: vitreous, or earthy. Form: massive, earthy, or stalactitic, incrusting.

Analyses: A. Ridge Avenue and School Lane, Falls of Schuylkill, Philadelphia. Eyerman, 1911, 21. B. Gap mine, Lancaster County. Derived from the alteration of pyrrhotite. Genth, 1875, 151, analysis by W. Theo. Roepper.

	A	B
SO_3	17.83	13.97
Fe_2O_3	60.73	57.01
H_2O	21.00	28.83
	99.56	99.81

LOCALITIES: *Lancaster County:* Gap nickel mine; *Philadelphia:* Fairmount Park, Falls of Schuylkill, and Hestonville.

BOTRYOGEN

II III
$MgFeFe_2S_4O_{11}.18H_2O$ MONOCLINIC

Color: deep red. Streak: ochre yellow. Luster: vitreous. Translucent. Form: small prismatic crystals, usually in botryoidal or reniform aggregates. Taste slightly astringent. H = 2–2.5. Sp. gr. 2.04–2.14.

Composition: MgO 4.4, FeO 7.9, Fe_2O_3 17.4, SO_3 34.9, H_2O 35.4, = 100.

LOCALITY: *Lebanon County:* Cornwall, deep red crystalline aggregates.

URACONITE

Color: lemon-yellow, or orange. Form: amorphous, earthy, or scaly aggregates.

Composition: a hydrous uranium sulfate.

LOCALITIES: *Delaware County:* Avondale, Crozer's quarry in Chester, and Leiperville; *Philadelphia:* Fairmount Park opposite the old Fairmount Water Works.

TUNGSTATES, MOLYBDATES

SCHEELITE	$CaWO_4$	Tetragonal
STOLZITE	$PbWO_4$	Tetragonal
WULFENITE	$PbMoO_4$	Tetragonal
MOLYBDITE	$Fe_2Mo_3O_{12}.7H_2O$	Orthorhombic

SCHEELITE

$CaWO_4$ TETRAGONAL

Color: white, yellow, brown, green. Streak: white. Transparent to translucent. Luster: vitreous. Form: massive, granular or columnar; pyramidal crystals. H = 4.5–5. Brittle. Sp. gr. 5.9–6.1.

Composition: $CaWO_4$; CaO 19.4, WO_3 80.6, = 100.

Analysis: Hoffman's quarry, Frankford, Philadelphia. Crystals in quartz. Eyerman, 1911, 22.

WO_3	78.90
MoO_3	2.39
CaO	18.11
	100.40

LOCALITIES: *Adams County:* Buchanan Valley, in spherulitic rhyolite with piedmontite; *Berks County:* Jones mine? *Philadelphia:* Hoffman's quarry.

STOLZITE

$PbWO_4$ TETRAGONAL

Color: green, yellow, brown, red. Streak: uncolored. Translucent. Luster: resinous, subadamantine. Form: acute octahedral crystals, drusy aggregates. H = 2.75–3. Brittle. Sp. gr. 7.87–8.13.

Composition; $PbWO_4$; PbO 49.0, WO_3 51.0, = 100.

LOCALITY: *Chester County:* Wheatley mines: yellowish-gray pyramidal crystals on quartz or pyromorphite.

WULFENITE

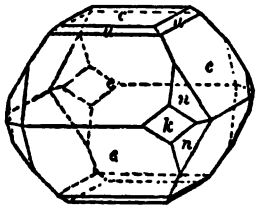
$PbMoO_4$ TETRAGONAL

Color: wax-yellow, orange, bright red. Streak: white. Subtransparent to subtranslucent. Luster: resinous to adamantine. Form: square tabular or pyramidal crystals; granular, massive. H = 2.75–3. Brittle. Sp. gr. 6.7–7.0.

Crystallography: Tetragonal, with pyramidal hemihedrism; c, p_0 = 1.5774. Forms: *c* (001), *a* (100), *m* (110), *f* (320), *k* (210), *n* (111), *s* (113), *e* (101), *u* (102), *β* (1.0.12), Wheatley mines.[92] Cleavage: *n*, perfect, *c*, *s*, less so. Fracture: subconchoidal.

Composition: $PbMoO_4$; PbO 60.7, MoO_3, 39.3 = 100. Ca may replace Pb, and Cr and Va may be present.

[92] Smith, 1855, 245; Dana, 1868, 607; Schrauf, 1871, 184, Koch, 1882, 403.



109

110

Figs. 109–110. Wulfenite, Wheatley mines (*Goodenough; Dana*).

Analyses: Wheatley Mine, Chester County. A. Red. Groth, 1883, 593, analysis by F. Jost. B. Red. Smith, 1855, 248. C. Yellow. Smith, 1855, 248.

	A	B	C
MoO_3	39.21	37.47	38.68
CrO_3	0.38	——	——
V_2O_3	——	1.28	——
PbO	60.00	60.30	60.48
	99.59	99.05	99.16
Sp. gr.			6.95

LOCALITIES: *Chester County:* Wheatley mines; bright yellow or red, tabular or pyramidal crystals, with pyromorphite; *Lancaster County:* Pequa mines; *Montgomery County:* Ecton and Perkiomen mines.

MOLYBDITE

Color: straw-yellow. Luster: earthy. Form: earthy pulverulent incrustations. Sp. gr. 4.49–4.50.

Composition: Fe_2O_3. $3MoO_3$. $7H_2O$.

LOCALITIES: *Delaware County:* Green's farm near Upland; *Philadelphia:* Frankford.

V

MINERAL LOCALITIES OF PENNSYLVANIA

ADAMS COUNTY[93]

Butler Township

Goldenville. Just west of Goldenville (Gettysburg 4172). Triassic shales, diabase dike and sill.

Glauberite crystal cavities: in shale (Stose, 1919, 1).

Center Mills Ore Bank. Triassic shales and diabase.

Chloritoid: dark greenish-black scales or small plates (Genth, 1876, 226; analysis).

Cumberland Township

Gettysburg. Vicinity of Gettysburg. Triassic shales and diabase.

Quartz: radiating (Rogers, 1858, II, 689, 692). *Magnetite:* massive, octahedral crystals (Genth, 1875, 38). *Hematite:* micaceous, iron-black or red; north of Gettysburg (Genth, 1875, 34). *Copper:* south of Gettysburg (Genth, 1875, 5). *Bornite:* south of Gettysburg (Genth, 1875, 13). *Tetrahedrite:* in epidote rock just south of Gettysburg, locality exhausted (Sadtler; Genth, 1875, 24). *Malachite:* south of Gettysburg (Genth, 1875, 24). *Chalcedony:* pale blue (Genth, 1875, 59).

Cemetery Hill. Gutters along road leading from the top of Cemetery Hill, and near the Soldier's Home, Gettysburg. Triassic shales and diabase.

Epidote: pyramidal crystals (Genth, 1876, 220; Frazer, 1877, 263.)

Marsh Creek. Marsh Creek, 4 miles west of Gettysburg, Cumberland township. Triassic shales and diabase; hydrothermal metamorphic veins.

Prehnite: (Rogers, 1858, II, 689).

Mummasburg. One and one-half miles southeast of Mummasburg, Cumberland township (Fairfield 661?). Triassic shales, diabase dike.

Glauberite crystal cavities: in shale (Stose, 1919, 1).

Germany Township

Littlestown. Willets, south of Littlestown, Germany township. Chloritic schists (metapyroxenite?)

Chlorite: (Genth, 1876, 227; analysis).

Hamiltonban[94] Township

Virgin Copper Mine, 1 mile N. N. E. of Monterey (Fairfield 7881).

Bingham and National Mines, 2 miles N. E. of Monterey (Fairfield 7954 and 7952).

Reed Hill Mine, 2½ miles N. E. of Monterey (Fairfield 7658), on Toms Creek.

Russell and Bechtel Mines, 4 miles N. N. E. of Monterey (Fairfield 7658 and 7661).

Snively Mine, ¾ mile northeast of Mt. Hope (Fairfield 7395).

Eagle Metallic Mine, on Miney Branch, ¾ mile due east of Charmian Station (Emmitsburg 1265).

Headlight Mine, east of Charmian Station (Emmitsburg 1228).

A number of prospects occur on the lower eastern slope of Jacks Mountain.

Precambrian basalts, rhyolites, aporhyolites, and rhyolite porphyries; Cambrian quartzite. Hydrothermal veins occur along shear zones in the altered basalts; epidotization has occurred in the latter adjacent to the shear zones, with later mineralization forming the hydro-

[93] Pyrite crystals in hornstone were reported on South Mountain, 5 miles from Sulphur Springs, by Seybert (1808, 157).

Lamellar hematite resembling ilmenite has been reported by Genth (1875, 38), from this county, but with no data as to the exact locality.

[94] For descriptions of the geology and mineral deposits of the township see Bascom, 1896; Stose, 1910; Wherry, 1911, 151–162; and Williams, 1892, 482.

thermal veins. Many attempts have beem made to work the veins for copper. The minerals also occur in amygdaloidal cavities in basalt and rhyolite.

Basalt; hydrothermal metamorphs: *Epidote:* (Silliman, 1822, 256). *Chlorite:* (Bascom, 1896).

Hydrothermal veins; primary: *Quartz:* stained blue and green by copper carbonates, or purplish by hematite (Silliman, 1822, 256). *Hematite:* specular (Wherry, 1911, 151–162). *Copper:* masses of several pounds (Cleaveland, 1816, 450). *Cuprite:* (Silliman, 1822, 256).

Weathering products: *Malachite:* (Silliman, 1822, 256). *Azurite:* (Silliman, 1822, 256).

MONTEREY. Head of Miney Run, below the Clermont House. Aporhyolite, hydrothermal metamorphic veins.

Piedmontite: (Williams, 1893, 55).

PINE MOUNTAIN. West flank of Pine Mountain, $1^1/_2$ miles north of Monterey (Fairfield 7891). Aporhyolite; hydrothermal metamorphic veins.

Piedmontite: deep carmine-red spherulitic aggregates of needles in rhyolite (Williams, 1893, 53–55; analysis).

FRANKLIN TOWNSHIP

BUCHANON VALLEY. Buchanon Valley, $2^3/_4$ miles north of the Chambersburg turnpike; Franklin township (Fairfield 2742.7). Rhyolites.

Hydrothermal minerals: *Quartz:* (Williams, 1893, 51). *Hematite:* (Williams, l. c.). *Scheelite:* in spherulitic rhyolite (Williams, l. c.). *Piedmontite:* radiating needles and microscopic crystals in scheelite (Williams, l. c.).

CASHTOWN. Near Cashtown, Franklin township. Triassic shales and diabase.

Magnetite: has been mined (Schrader, Stone and Sanford, 1917, 264).

LATIMORE TOWNSHIP

BERMUDIAN CHURCHES. Three-quarters of a mile northwest of Bermudian Churches, on Bermudian Creek, Latimore township (Carlisle 9799). Triassic shales and diabase.

Glauberite crystal cavities: in shale (Stose, 1919, 1).

ALLEGHENY COUNTY

VICINITY OF PITTSBURGH. Carboniferous sedimentary rocks. The following minerals have been met in coal mines, and in exposures along roads, or along streams.

Siderite: (Genth, 1875, 11). *Galena:* cubes in siderite (Genth, 1875, 11). *Calcite:* veins in limestone (Aigster, 1813, 212). *Aragonite:* silky, fibrous, crystalline seams and crusts (Genth, 1875, 162). *Alunogen:* efflorescences (Mease, 1807, 409). *Steatite?* "on the Allegheny River, 7 miles from Pittsburgh" (Aigster, 1813, 212).

BEAVER COUNTY

NEW BRIGHTON. Near New Brighton, Pulaski township. Carboniferous sedimentary rocks.

Siderite: (Genth, 1875, 146). *Barite:* white laminated masses in nodules of argillaceous siderite (Genth, 1875, 146).

BEDFORD COUNTY[95]

ROBINSONVILLE. West side of Wray's Hill, east of Robinsonville, Monroe township. Pocono sandstone.

Residual weathering products: *Limonite:* (Stevenson, 1882, 211). *Pyrolusite:* (Stevenson, 1882, 211).

[95] The following minerals have been reported from the county without precise localities: *Amethyst:* East Bedford (Schrader, Stone, and Sanford, 1917, 259). *Barite:* Bridgeport; small tabular crystals in Catskill red sandstone (Lewis, 1882, 38). *Calcite:* Cumberland Valley, 15 miles north of Bedford (Seybert, 1808, 263); amber-colored masses. *Löllingite:* (Leonhard, 1849, 809) described by Shepard, 1828, 183–186, as a meteoric iron; Genth, 1875, 6, called it spiegeleisen. Shepard's analysis follows: Fe 97.44, As 1.56, C 0.40, loss 0.60, = 100.

BERKS COUNTY

Albany Township

Quartz: smoky; on Berg's farm (Eyerman, 1889, 14).

Alsace Township

Trexler Mica Mine. Three-quarters of a mile N. E. of McKnight's Gap, and 1/4 mile south of school. (Reading 5557). Granitic pegmatite.

Allanite: large masses (E. T. Wherry, priv. comm.) *Zircon:* (Wherry, priv. comm.) *Autunite:* (Eyerman, 1911, 20). *Torbernite:* (Eyerman, 1911, 20).

Valentine Hartman's Mine.[96] On the west bank of Antietam Creek, 3/4 of a mile west of Spies Church. (Reading 5647). Granite and pegmatite.

Molybdenite: plates and scales (Wetherill, 1852, 273; analysis).

Gottschall's Mine. On the west side of a hill on H. S. Gottschall's farm, 1 1/2 miles N. N. W. of Spies Church. (Reading 5378). Gabbro.

Garnet: (D'Invilliers, 1883, 397). *Pyroxene, diallage:* dark greenish cleavage masses (Genth, 1876, 219; analysis). *Pyrrhotite:* slightly nickeliferous; disseminated masses (Genth, 1876, 219).

Gottschall's farm. One and a half miles N. N. W. of Spies Church. Hardyston quartzite.

Jasper, agate-jasper, and agate: (D'Invilliers, 1883, 401).

Salem Church. Ochre pit, 1/2 mile east of Salem Church; on the south side of a hill. (Reading 5341). Cambrian quartzite; residual deposit of limonite and goethite.

Goethite: occurs in geodes up to 2 feet across. *Limonite:* ochre filling geodes.

Weist School. Small quarry, 3/4 mile west of Weist school; (Reading 6487). Precambrian gneisses.

Crocidolite: (E. T. Wherry, priv. comm.)

Bern Township

Leinbach's Hill. Five miles northwest of Reading.

Fluorite: deep blue to purple cubes (D'Invilliers, 1883, 397). *Calcite:* pink, in bluish quartz (D'Invilliers, 1883, 395). *Quartz:* lilac colored (D'Invilliers, 1883, 400).

Caernarvon Township

Jones Mine. Three quarters of a mile east of Joanna; or 2 miles northeast of Morgantown. (Honeybrook 2984). Cambro-ordovician limestone, Triassic red sandstones and shales, intrusive diabase; hydrothermal deposits of magnetite, replacing the limestone; tactite.

Limestone; contact metamorphs (tactite): *Actinolite:* (D'Invilliers, 1883, 394). *Byssolite:* (Wheatley, 1882, 36). *Serpentine; retinalite:* (D'Invilliers, 1883, 401). *Ripidolite:* (Genth, 1875, 132). *Talc:* (Dana, 1868, 777). *Graphite:* (D'Invilliers, 1883, 397). *Apatite?* small, white crystals in magnetite (Genth, 1875, 139).

Tactite; weathering products: *Kaolinite:* contains up to 10% Cu (Genth, 1875, 121). *Venerite:* a green chloritic mixture containing Cu (Hunt, 1876, 325; analysis). *Allophane:* white, blue, mammillary coatings (Genth, 1875, 107).

Hydrothermal deposits; primary minerals: *Copper:* crystallized and arborescent (Cleaveland, 1822, 555). *Pyrite:* (Dana, 1850, 653). *Chalcopyrite:* large tetrahedra, often tarnished and coated with malachite (Dana, 1844, 545; Genth, 1875, 21). *Chalcocite:* granular compact (D'Invilliers, 1883, 395). *Bornite:* (D'Invilliers, 1883, 395). *Cuprite:* (D'Invilliers, 1883, 396). *Melaconite:* (Wheatley, 1882, 36); *Magnetite:* dodecahedral and octahedral crystals (Dana, 1844, 545). *Scheelite:* a specimen in Lehigh University is labeled as coming from this locality.

Hydrothermal deposits: hydrometamorphs: *Calcite:* (Genth, 1875, 154). *Aragonite:* acicular crystals, fibrous coatings (Dana, 1868, 777). *Malachite:* green, fibrous and botryoidal masses (Dana, 1844, 545). *Aurichalcite:* (Wheatley, 1882, 36). *Cerussite:* (Dana, 1850, 653). *Chrysocolla:* massive, botryoidal or stalactitic coatings, greenish-blue. Dana, 1844, 545; Genth, 1875, 105). *Gypsum:* acicular crystals, rare (D'Invilliers, 1883, 398).

[96] This locality has been variously known as Zion Church or "Reading" (Dana, 1854, 488).

Diabase; hydrothermal metamorphs: *Stilbite:* (D'Invilliers, 1883, 402).

Two miles northeast of Jones Mine: *Graphite:* (Dana, 1850, 653). *Titanite:* (Dana 1850, 653).

CUMRU TOWNSHIP

OPPOSITE FRITZ ISLAND. Exposure on the east side of Schuylkill River, at the little dam, opposite Fritz Island, 2 miles south of Reading. Triassic diabase intrusive.

Oligoclase or *albite:* (D'Invilliers, 1883, 396).

FRITZ ISLAND MINES.[97] Northern end of Fritz Island in the Schuylkill River, 2 miles south of Reading. (Reading 7397). Cambrian sandstone, Cambro-ordovician ("Trenton") limestone, Triassic limestone conglomerate; intrusive diabase; hydrothermal deposits of magnetite replacing the Cambro-ordovician limestone; tactite (hydrothermal contact metamorphosed limestone). The mines are abandoned, and practically inaccessible.

Limestone; contact metamorphs (tactite): *Wernerite:* resinous white crystals (D'Invilliers, 1883, 492). *Vesuvianite:* yellow and orange crystals (D'Invilliers, 1883, 402; Brunner and Smith, 1883, 280; Genth, 1875, 73). *Grossularite:* grayish-green, granular (Genth, 1875, 73). *Serpentine, retinalite:* yellowish-brown to dark olive-green (Genth, 1875, 114; D'Invilliers, 1883, 401). *Talc:* (D'Invilliers, 1883, 401). *Chlorite:* (Genth, 1875, 133; D'Invilliers, 1883, 401).

Tactite; hydrometamorphs: *Quartz:* small crystals (D'Invilliers, 1883, 400). *Chalcedony:* (Eyerman, 1889, 14). *Calcite:* scalenohedral crystals; granular masses (Genth, 1875, 154; D'Invilliers, 1883, 395). *Brucite:*[98] pearly white to yellow, crystals, crystalline masses or seams in dolomitic limestone (D'Invilliers, 1883, 395; Genth, 1885, 40; analyses). *Fluorite:* pale yellow cubes, with calcite (D'Invilliers, 1883, 397; Eyerman, 1889, 7).

Tactite: weathering products: *Deweylite:* white, yellowish-white or brownish amorphous, stalactitic or botryoidal coatings; also pseudomorphs after aragonite? (Genth, 1885, 41; analysis). *Aragonite:* acicular crystals, fibrous coatings (Genth, 1875, 162).

Hydrothermal deposits; primary minerals: *Magnetite:* octahedral and dodecahedral crystals (Genth, 1875, 38; D'Invilliers, 1883, 398). *Hematite:* micaceous and specular (D'Invilliers, 1883, 398). *Stibnite:* minute dark, lead-gray prismatic crystals, longitudinally striated; observed with zeolites by Samuel Tyson (Genth, 1875, 9). *Galena:* (D'Invilliers, 1883, 397). *Pyrite:* crystals and masses (D'Invilliers, 1883, 399). *Bornite:* (D'Invilliers, 1883, 395). *Chalcopyrite:* (Genth, 1875, 21). *Chalcocite:* granular, compact (D'Invilliers, 1883, 395).

Hydrothermal deposits; hydrometamorphs: *Malachite:* fibrous, radiating, and botryoidal coatings (Genth, 1875, 167; D'Invilliers, 1883, 398). *Azurite:* small crystals (Genth, 1875, 168). *Aurichalcite:* (D'Invilliers, 1883, 394). *Chrysocolla:* (D'Invilliers, 1883, 395).

Hydrothermal deposits; weathering products: *Limonite:* (D'Invilliers, 1883, 398).

Diabase; hydrothermal metamorphs: *Datolite:* minute crystals (D'Invilliers, 1883, 396). *Apophyllite:* colorless to white, tabular or pyramidal crystals, often in rosettes (Genth, 1875, 107; Sadtler, 1883, 357; analysis). *Stilbite:* (D'Invilliers, 1883, 402; Brunner and Smith, 1883, 280). *Gismondite?* white, translucent, pseudo-tetragonal crystals (Genth, 1885, 42; 1875, 110; Eyerman, 1911, 12; analyses). *Chabazite:* colorless crystals (Genth, 1875, 109; analysis; Sadtler, 1883, 356). *Thomsonite:* small spherical concretions of fine radiated structure, white, waxy to pearly (Genth, 1875, 108). *Mesolite:* minute white tufts of radiating needles (Genth, 1875, 108; analysis; Sadtler, 1883, 357).

RAUDENBUSH MINE. One mile south of Oakland, just south of Angelica Creek, at the base of a trap hill. (Reading 7621). Cambro-ordovician limestone; Triassic diabase intrusive, hydrothermal deposits of magnetite replacing the limestone; tactite.

Pyroxene: (D'Invilliers, 1883, 399). *Chlorite:* (D'Invilliers, 1883, 395). *Pyrrhotite:* (D'Invilliers, 1883, 400). *Magnetite:* massive; octahedral crystals. *Stilbite:* radiating crystals in hydrothermal metamorphic veins in diabase (Genth, 1875, 109; Smith, 1885, 414, analysis by Davidson).

[97] For a description of the workings and geology of the deposits, see Spencer, 1908, 38.

[98] It is perhaps more probable that brucite, and possibly fluorite, calcite and quartz, were formed by hydrothermal solutions at a late stage, after the formation of serpentine.

CUMRU TOWNSHIP, IN GENERAL.

Calcite: occurs at Shillington (D'Invilliers, 1883, 395). *Limonite* or *goethite:* botryoidal and dendritic; pseudomorphs after pyrite, occurs southwest of Reading, near the Lancaster Bridge, on S. Slegel's farm (D'Invilliers, 1883, 398). *Wad:* mammillary concretions; on the Morgantown road, near Oakland (Genth, 1876, 218).

CENTER TOWNSHIP

Hornblende: Henry Ruth's farm at Mohrsville (D'Invilliers, 1883, 394). *Pyrite:* nodular, radiating (D'Invilliers, 1883, 399).

COLEBROOKDALE TOWNSHIP

BOYERTOWN. Railroad cuts on the Colebrookdale Branch, P. & R. Ry., south of Boyertown. Triassic intrusive diabase.

Pyroxene: (D'Invilliers, 1883, 399). *Stilbite:* hydrothermal metamorphic veins in diabase (D'Invilliers, 1883, 402).

BOYERTOWN IRON MINES. One-quarter mile southwest of Boyertown. (Boyertown 8135, 8136, 8156). Cambro-ordovician limestones; Triassic red shales and sandstone; intrusive diabase; hydrothermal deposits replacing limestone; tactite.

Limestone; contact metamorphs (tactite): *Pyroxene:* (Eyerman, 1889, 15). *Amphibole; mountain-leather, byssolite:* (D'Invilliers, 1883, 394). *Epidote:* (D'Invilliers, 1883, 396). *Serpentine:* (D'Invilliers, 1883, 401). *Chlorite:* (D'Invilliers, 1883, 395).

Hydrothermal deposits; primary minerals: *Magnetite:* octahedral and dodecahedral crystals (D'Invilliers, 1883, 398). *Pyrite:* octahedral crystals (D'Invilliers, 1883, 399). *Pyrhotite?* (D'Invilliers, 1883, 400). *Chalcopyrite:* (Eyerman, 1889, 6). *Cuprite:* (D'Invilliers, 1883, 396). *Agate, agate-jasper, hornstone, flint, and basanite* are also reported from this locality (D'Invilliers, 1883, 400).

FEGLEY'S FARM. One and a half miles northeast of Boyertown.

Graphite: (D'Invilliers, 1883, 397). *Fayalite?* (D'Invilliers, 1883, 396).

DANIEL HIMMELREICH'S FARM. Near Boyertown. Graphitic gneiss.

Graphite: (D'Invilliers, 1883, 397).

BECHTEL'S FARM. Graphite prospect on side of hill north of the road, 1/4 mile N. E. of Gabelsville. (Boyertown, 5781). Another prospect is found 1/4 mile to the east (Boyertown 5786). Graphitic gneiss. *Graphite:* (D'Invilliers, 1883, 397).

DOUGLASS TOWNSHIP

LITTLE OLEY. Exposures 1/4 mile east of Little Oley. (Boyertown 8186). Triassic sandstone, etc.

Crocidolite: (Bliss, 1913, 519).

EARL TOWNSHIP[99]

GABELSVILLE. Exposures 1 1/4 miles northwest of Gabelsville. (Boyertown 4932) Granite gneiss, and meta-gabbro (Precambrian).

Crocidolite: (Bliss, 1913, 519), hydrothermal metamorph.

SHANESVILLE. Exposures 1 1/4 miles southeast of Shanesville (Boyertown 4952), and cut of the Oley Valley Electric R. R. 3/4 miles east of Shanesville (Boyertown 4627). Precambrian granite gneiss and meta-gabbro.

Crocidolite: hydrothermal metamorph (Bliss, 1913, 519; analyses).

EXETER TOWNSHIP

OPPOSITE POPLAR NECK. Exposures in the railroad cut on the Schuylkill River, east of Poplar Neck, and south of Neversink Mountain.

Calcite: scalenohedral crystals (D'Invilliers, 1883, 395). *Fluorite:* deep blue cubes (D'Invilliers, 1883, 397; Eyerman, 1889, 7). *Malachite:* (Eyerman, 1889, 45).

[99] *Magnesite?* occurs at Spang's iron mine, on Furnace Hill, southwest of Furnace Creek, one mile east of Spangsville, (Boyertown, 4814). *Amphibole asbestus.* at Earlville on the Manatawny (D'Invilliers, 1883, 394). *Kaolinite:* Twelve miles north of Douglassville (Genth, 1875, 119).

JACKSONWALD. Exposures along the Antietam Creek, 1 mile south of Jacksonwald. Triassic extrusive basalt; hydrothermal minerals in amygdaloidal cavities in the basalt.

Calcite: (Wherry, 1910, 12). *Prehnite:* (Wherry l. c.). *Datolite:* (Wherry l. c.). *Stilbite:* (Wherry, 1910, 24). *Heulandite:* (Wherry, 1910, 24). *Chabazite:* (Wherry, 1910, 24). *Quartz:* (Wherry, 1910, 24).

KINSEY HILL.[100] Exposures along road west of Kinsey Hill, 1 1/2 miles south of Jacksonwald. Triassic diabase sill.

Garnet: (D'Invilliers, 1883, 397). *Chalcedonic jasper* and *jasper:* (D'Invilliers, 1883 400). *Calcite:* pink (D'Invilliers, 1883, 395).

SNYDERSVILLE.

Malachite: (Eyerman, 1889, 45).

GREENWICH TOWNSHIP

Quartz: transparent crystals at Windsor (Eyerman, 1889, 13). *Chalcedonic jasper* and *jasper:* (D'Invilliers, 1883, 400). *Calcite:* (D'Invilliers, 1883, 395).

HEIDELBERG TOWNSHIP

Barite: brownish, fetid, columnar and radiating masses (Genth, 1875, 146).

HEREFORD TOWNSHIP

SIESSHOLTZVILLE. P. & R. Mine, 1/4 mile east of Siessholtzville. Precambrian gneisses.

Orthoclase: (Prime, 1875, 6; analysis by Castle). *Oligoclase* or *albite:* (D'Invilliers, 1883, 396). *Salite:* (Prime, 1875, 6, analysis by Headden). *Prochlorite:* (D'Invilliers, 1883: 399). *Magnetite:* (D'Invilliers, 1883, 397). *Pyrite:* (D'Invilliers, 1883, 399). *Graphite,* (D'Invilliers, 1883, 397). *Limonite,* red ochre: (D'Invilliers, 1883, 399).

RAUCH'S MINE. Three-quarters of a mile north of Huff Church, on the western spur. of a small hill, west of the road to Siessholtzville. (Boyertown 2564). Precambrian gneisses.

Pyroxene: crystals (D'Invilliers, 1883, 399). *Titanite:* clove-brown crystals in magnetite (Brunner and Smith, 1883, 280).

HUFF CHURCH.

Orthoclase: (D'Invilliers, 1883, 396). *Muscovite:* (D'Invilliers, 1883, 399). *Biotite:* (D'Invilliers, 1883, 399). *Magnetite:* titaniferous (D'Invilliers, 1883, 398).

DALE. Mines 3/4 of a mile north of Dale. (Boyertown 2867, and 2868). Precambrian gneisses.

Titanite: (D'Invilliers, 1883, 401).

LONGSWAMP TOWNSHIP

TOPTON.

Serpentine: (D'Invilliers, 1883, 401). *Talc:* (D'Invilliers, 1883, 401). *Prochlorite:* (D'Invilliers, 1883, 399).

MERTZTOWN.

Chalcedonic jasper and *jasper:* (D'Invilliers, 1883, 400).

LONGSWAMP CHURCH. Neighborhood of Longswamp Church, 1/4 mile S. E. of Longswamp. *Chloropal:* (Eyerman, 1889, 35).

FEGLEY'S MINE. One mile S. W. of Maple Grove, close to Swope Creek. Precambrian gneisses. (Boyertown 2284).

Stilbite: masses of white radiating needles (Smith, 1885, 414; analysis by Hoskinson and Brunner).

LONGSWAMP TOWNSHIP, IN GENERAL.

Graphite: Schmeck's farm (D'Invilliers, 1883, 397). *Epidote:* on Schmeck's farm south of Longswamp, and on Hancock and Wetzel's farm (D'Invilliers, 1883, 396). *Actinolite, byssolite:* (D'Invilliers, 1883, 394). *Kaolin:* Schmeck's farm (D'Invilliers, 1883, 398).

[100] The locality has also been known as "Hartzog's Mill, formerly Bishop's Mill, and Kinzi's Mill.

LOWER ALSACE TOWNSHIP

MOUNT PENN.

Orthoclase: On the eastern slope (D'Invilliers, 1883, 396). *Epidote:* on the eastern slope (Genth, 1875, 79). *Kaolin:* on the eastern slope (D'Invilliers, 1883, 398). *Lepidocrocite:* on P. D. Wanner's farm (D'Invilliers, 1883, 397). *Turgite:* (D'Invilliers, 1883, 402).

ESTERLY.

Quartz, smoky: on the Boyertown road, 4 miles east of Reading (D'Invilliers, 1883, 400).

STONY CREEK MILLS.

Augite: (D'Invilliers, 1883, 399). *Orthoclase:* red, at Ohlinger's Mill, 1/8 mile east of Stony Creek Mills P. O. (D'Invilliers, 1883, 396).

ANTIETAM RESERVOIR. Exposures on the west side of the Reservoir, opposite Ohlinger Dam, 1/2 mile north of Stony Creek Mills. (Reading 5835). Precambrian gneisses.

Orthoclase: (D'Invilliers, 1883, 396). *Labradorite:* (D'Invilliers, 1883, 396). *Augite:* (D'Invilliers, 1883, 399). *Hornblende:* (D'Invilliers, 1883, 394). *Actinolite:* (D'Invilliers, 1883, 394). *Amphibole asbestus:* (D'Invilliers, 1883, 394). *Epidote:* (D'Invilliers, 1883, 396). *Garnet:* (Eyerman, 1889, 18). *Muscovite:* (D'Invilliers, 1883, 399). *Graphite:* (Eyerman, 1889, 3). *Molybdenite?* (D'Invilliers, 1883, 399). *Pyrrhotite:* (D'Invilliers, 1883, 400). *Rutile?* (D'Invilliers 1883, 401). *Stilbite:* (D'Invilliers, 1883, 402).

MAIDEN CREEK TOWNSHIP

Wad: on Nathan Althouse's farm, Maiden Creek (D'Invilliers, 1883, 402).

MAXATAWNY TOWNSHIP

LYONS.

Wad: (D'Invilliers, 1883, 402). *Xanthosiderite:* (D'Invilliers, 1883, 402).

MUHLENBERG TOWNSHIP

BERNHARTS.[101]

Epidote: (Genth, 1876, 220). *Garnet; spessartite:* massive (Genth, 1875, 75); *andradite?* small reddish-brown crystals (Genth, 1876, 220). *Zircon:* (D'Invilliers, 1883, 402). *Siderite:* (Genth, 1875, 159).

BROOK'S QUARRY. North of Reading.

Fluorite: small purple crystals (D'Invilliers, 1883, 397).

OLEY TOWNSHIP

DETURK'S QUARRIES. On DeTurk's farm, 1/2 mile north of Griesmersville. (Reading 6688, and 6921).

Calcite: pale pink rhombohedra (Genth, 1876, 228). *Fluorite:* violet granular masses (Genth, 1876, 210).

WEAVER MINE. Two miles northeast of Oley Line, and 1/4 mile west of Livingood School. (Reading 6567).

Siderite: (D'Invilliers, 1883, 401).

HUNTER'S MINE. On Kemp's farm, 1 mile south of Friedensburg (Reading 6564).

Kaolin: (D'Invillier's, 1883, 398).

LEE'S FARM. Two miles east of Friedensburg, and 3/4 of a mile south of Brumback School.

Quartz: crystals up to 2 inches in length (Genth, 1875, 56).

MERKLE'S FARM. One and three-quarters miles southwest of Friedensburg, and 1/4 mile north of the Weist School; east of Monocacy Creek.

Damourite: (D'Invilliers, 1883, 396).

FRIEDENSBURG.

Quartz: blue, amethystine (D'Invilliers, 1883, 400). *Hornstone, silicified wood, basanite,* and *chalcedony* (Genth, 1876, 218, Eyerman, 1889, 14).

ONTELAUNEE TOWNSHIP

Marcasite? at Leesport (D'Invilliers, 1883, 398).

[101] W. Hartman's farm was east of this place.

Penn Township

Bernville.

Pyrite: radiating nodules, altered on the surface to limonite. *Barite:* fetid, columnar, radiating masses.

Perry Township

Luckenbill's Cave.

Calcite: scalenohedral crystals (D'Invilliers, 1883, 395).

Pike Township

Hill Church. Exposures 1/4 mile east of Hill Church, and 3/4 mile east of Hill Church (Boyertown 4633 and 5416). Precambrian granite gneiss.

Crocidolite: hydrothermal metamorph (Bliss, 1913, 519).

Lobachsville.

Hematite: massive (D'Invilliers, 1883, 398).

Reading

Gold: in ferruginous quartz, found at 8th and 9th Streets, Reading, and near the suburb of Hampden, at the western base of Mount Penn. (Wetherill, 1854, 234; D'Invilliers, 1883, 397). *Silver:* traces (D'Invilliers, 1883, 401). *Quartz, agate-jasper, jasper:* (Dana, 1868, 777; Genth, 1876, 60). *Lepidocrocite:* at the head of Walnut street (D'Invilliers, 1883, 397). *Limonite:* North Reading (D'Invilliers, 1883, 398). *Calcite:* North Reading (Genth, 1876, 228). *Gypsum:* Bushong's mine, northern part of Reading (D'Invilliers, 1883, 398).

Rockland Township

Flint Hill. One mile south of Bowers Station. Hardyston quartzite.

Quartz: drusy, milky, blue, pink, ferruginous: (D'Invilliers, 1883, 400). *Chalcedonic jasper, jasper, agate, flint:* (D'Invilliers, 1883, 400). *Limonite; ochre:* (D'Invilliers, 1883, 399). *Xanthosiderite:* (D'Invilliers, 1883, 402). *Molybdenite?* (D'Invilliers, 1883, 399).

Oley-Hamburg Road. Near Friedensburg. Hardyston quartzite.

Chalcedony, agate, jasper, flint, basanite: (D'Invilliers, 1883, 400; Genth, 1875, 59).

Green Hill.[102] One and three-quarter miles N. E. of Oley Furnace. Cambrian quartzite and damourite schists.

Quartz: lilac-colored (D'Invilliers, 1883, 400). *Damourite:* pale grayish-green to light brown, massive (Genth, Jr., 1882, 47). *Psilomelane:* (D'Invilliers, 1883, 399).

Richmond Township

Fleetwood.

Quartz: doubly terminated crystals, at Noll's Mine (D'Invilliers, 1883, 400). *Chalcedony, jasper, flint, basanite:* (D'Invilliers, 1883, 400). *Epidote:* (D'Invilliers, 1883, 396). *Kaolin:* (D'Invilliers, 1883, 398). *Limonite, ochre:* (D'Invilliers, 1883, 399).

Kirbyville. Fields, and roadside gutters, northeast of Kirbyville.

Quartz: doubly terminated crystals, colorless (G. W. Geist, priv. comm.)

Moselem Mines. One mile northeast of Molltown (Reading 2261).

Chalcedony: oolitic? (D'Invilliers, 1883, 401). *Goethite:* (D'Invilliers, 1883, 397). *Turgite:* (D'Invilliers, 1883, 402).

Crystal Cave. Two miles east of Virginville; about 4 miles west of Kutztown.

Quartz: small colorless crystals (Genth, 1875, 56). *Calcite:* stalactites, often studded with aragonite crystals (Genth, 1875, 154). *Aragonite:* abundant in small crystals, forming crystalline radiating masses, and fibrous stalactites (Genth, 1875, 162).

Virginville.

Pyrite: globular, radiating (D'Invilliers, 1883, 399).

Kutztown.

Basanite: (D'Invilliers, 1883, 401).

[102] This was the site of Rockland Forges.

ROBESON TOWNSHIP

GICKERVILLE. Trap quarry on Indian Corn Creek, 3/4 mile S. W. of Gickerville. Triassic intrusive sill of diabase.

Hydrothermal metamorphs: *Calcite:* brilliant golden yellow rhombohedra. *Prehnite:* green, mammillary crystal aggregates. *Apophyllite:* colorless or white tabular crystals. *Stilbite:* colorless, white, and yellow; prismatic crystals, usually in sheaf-like aggregates, radiating, very abundant. *Epidesmine:* colorless or yellow prismatic crystals, rarely over 3 mm. in length. *Heulandite:* yellow crystals, small. *Chabazite:* colorless crystals, small. *Laumontite:* chalk white, prismatic crystals, radiating. *Natrolite:* radiations of white needle-like crystals. *Melaconite:* massive, black; coated with chrysocolla. *Arsenopyrite:* massive, disseminated. *Erythrite:* coatings on arsenopyrite.

BIRDSBORO.[103] Trap quarries, at Trap Rock on Hay Creek, one mile south of Birdsboro. Triassic intrusive diabase sill.

Hydrothermal metamorphs: *Calcite:* brilliant yellow, rhombohedral and scalendohedral crystals. *Prehnite:* green, mammillary (Smith, 1910, 538). *Apophyllite:* colorless, or white crystals (Smith, l. c., analysis). *Stilbite:* thin radiating crystals (Smith l. c., analysis). *Chabazite:* colorless or white rhombohedra (Smith, l. c., analysis). *Laumontite:* white, prismatic, radiating (Smith, l. c., analysis). *Natrolite:* (Smith, l. c.). *Scolecite:* masses of silky radiating needles, with minute calcite crystals on them (Smith, l. c., analysis). *Thomsonite:* minute crystals on natrolite.

RUSCOMBMANOR TOWNSHIP

PRICETOWN. Farms, 1/2 to 1 mile east of Pricetown.[104] (An old iron mine is situated on a hill 3/4 of a mile E. N. E. of Pricetown, Reading 3881). Precambrian gneisses.

Quartz, chalcedony, and *jasper:* (Genth, 1855, 21; D'Invilliers, 1883, 400). *Garnet:* (D'Invilliers, 1883, 397). *Zircon:* in magnetite; chocolate-brown, opaque, prismatic crystals up to 1 1/2 inches in length, often with rounded terminations (Wetherill, 1852, 273; Genth, 1875, 76; D'Invilliers, 1883, 402). *Allanite:* pitch-black, massive, with zircon and magnetite; often coated with a brownish decomposition product (Genth, 1855, 21, analysis; Sanderson Smith, 1855, 188). *Magnetite:* titaniferous; sometimes exhibiting polarity (Genth, 1855, 21; D'Invilliers, 1883, 401). *Xanthosiderite:* (D'Invilliers, 1883, 402).

BOMEGRATZ'S FARM. Two miles west of Pricetown. Hardyston quartzite.

Quartz: ferruginous and drusy (D'Invilliers, 1883, 400). *Chalcedony, agate,* and *jasper:* (D'Invilliers, 1883, 400).

UDRÉE MINE. One mile S. S. W. of Pricetown (Reading 6116). Cambrian sandstone; residual deposit of goethite. Mine is abandoned.

Goethite: (D'Invilliers, 1883, 397). *Lepidocrocite:* (D'Invilliers, 1883, 397). *Turgite:* thin layers on goethite, often iridescent (D'Invilliers, 1883, 402). *Limonite, ochre:* red, yellow (D'Invilliers, 1883, 399).

CLYMER MAGNETITE MINES. On the south flank of Furnace Hill, 1 1/2 miles south of Pricetown (Reading 6101, and 6162).

Muscovite: (D'Invilliers, 1883, 399). *Chlorite:* (D'Invilliers, 1883, 395). *Wad:* (D'Invilliers, 1883, 402).

WERNERSVILLE.

Calcite: (D'Invilliers, 1883, 395). *Agate, jasper:* (Eyerman, 1889, 14).

SINKING SPRING.

Goethite: (Genth, 1875, 48).

FRITZTOWN.

Calcite: (D'Invilliers, 1883, 396). *Fluorite:* pale yellow cubes up to 7/8 of an inch thick (D'Invilliers, 1883, 396).

Quartz: amethystine-blue (D'Invilliers, 1883, 400). *Chalcedony, jasper, flint:* (D'Invilliers, 1883, 401). *Damourite:* massive, lamellar, translucent (Genth, Jr., 1882, 47; analysis). *Magnetite:* massive (D'Invilliers, 1883, 398). *Limonite:* (D'Invilliers, 1883, 398).

[103] This is undoubtedly the locality given by Smith as "Railroad cut east of Reading," although lying 9 miles southeast of Reading.

[104] Farms of W. Haines, Schroeder, and Mrs. D. Rhodes of Genth. The locality has also been known as "Eckhardt's Furnace," and "Reading" (Smith, 1855, 188).

SPRING TOWNSHIP

CUSHION MOUNTAIN.

Chalcedonic jasper and *jasper:* (D'Invilliers, 1883, 400). *Silver:* traces (Dr. Brunner: Eyerman, 1889, 3).

BLANDON. Old iron prospect, on hill 1½ miles S. E. of Blandon (Reading 2863).

Wavellite: on limonite (Wherry, priv. comm.)

FOX'S FARM. Two and a half miles south of Blandon. Cambrian quartzite and damourite schists.

RUTH MINE. Three-eighths of a mile south of Fritztown, close to the road (Wernersville, 9527). Cambro-ordovician limestone, Triassic red sandstones and shales, intrusive diabase; hydrothermal deposits of magnetite replacing the limestone; tactite. Mine (open cut) is abandoned.

Limestone; contact metamorphs (tactite): *Serpentine, retinalite:* (D'Invilliers, 1883, 401; Genth, 1885, 42; analysis by Keller). *Chlorite:* curved hexagonal crystals (D'Invilliers, 1883, 399). *Apatite?* (Eyerman, 1889, 40).

Tactite; hydrometamorphs: *Brucite:* silky fibrous masses, or thin colorless laminae (Schoenfeld and Smith, 1883, 281; analysis; Genth, 1885, 40; analysis). *Hydromagnesite:* silky white, fibrous (Schoenfeld and Smith, 1883, 281). *Calcite:* (Genth, 1885, 40).

Tactite; weathering products: *Deweylite:* white and brownish resinous coatings (Genth, 1875, 40; Smith, 1883, 280, 2 analyses). *Aragonite:* (D'Invilliers, 1883, 394).

Hydrothermal deposits; primary minerals: *Pyrite. Magnetite:* massive; octahedral crystals.

WHEATFIELD MINES. One mile E. S. E. of Fritztown (Wernersville 9537 and 9562). Cambro-ordovician limestone, Triassic red sandstones and shales, intrusive diabase; hydrothermal deposits of magnetite replacing the limestone; tactite. The mines are abandoned.

Limestone; contact metamorphs (tactite): *Serpentine, retinalite*: (D'Invilliers, 1883, 401; Genth, 1885, 42; analysis by Keller). *Chlorite: prochlorite,* and *kammererite?* (D'Invilliers, 1883, 398–399).

Tactite: hydrometamorphs: *Calcite:* (D'Invilliers, 1883, 395). *Fluorite:* amber-colored crystals (D'Invilliers, 1883, 397). *Wavellite?* (D'Invilliers, 1883, 402).

Tactite; weathering products: *Deweylite:* brownish, resinous, coatings. *Aragonite:* (D'Invilliers, 1883, 394).

Hydrothermal deposits; primary minerals: *Pyrite:* (D'Invilliers, 1883, 399). *Magnetite:* massive; octahedral crystals.

Hydrothermal deposits; weathering products: *Limonite:* (D'Invilliers, 1883, 398). *Malachite:* (Eyerman, 1889, 45).

Diabase; hydrothermal metamorphs: *Calcite:* crystals (Brunner and Smith, 1883, 279). *Stilbite:* pearly white, radiating, fibrous (Brunner and Smith, 1883, 279; analysis).

TULPEHOCKEN TOWNSHIP

MT. ETNA.

Barite: (D'Invilliers, 1883, 395).

UNION TOWNSHIP

Quartz, smoky: on Updegroff's farm (D'Invilliers, 1883, 400). *Wad:* globular, near Birdsboro (D'Invilliers, 1883, 402).

WASHINGTON TOWNSHIP

BARTO. Iron ore pit south of Barto. Granite gneiss and meta-gabbro.

Crocidolite: hydrothermal metamorph (Bliss, 1913, 519).

ESHBACH. Hill just southwest of Eshbach. Franklin limestone?

Pyroxene: (D'Invilliers, 1883, 399). *Garnet:* (D'Invilliers, 1883, 397).

ESHBACH. Exposures ½ mile west of Eshbach. (Boyertown 5521). Precambrian granite gneiss.

Crocidolite: hydrothermal metamorph (Bliss, 1913, 519).

GILBERT'S ORE PIT. One and three-quarters miles north of Bechtelsville. (Boyertown 5274). Precambrian granite gneiss and meta-gabbro.

Oligoclase or *albite:* (D'Invilliers, 1883, 396). *Crocidolite:* (Bliss, 1913, 519). Also found in exposures about 1/4 mile west of the pit.

SPARR'S MINE. Three-eighths of a mile east of Dale, just south of the Churchville Road (Boyertown 5314).

Pyroxene: (D'Invilliers, 1883, 399).

WINDSOR TOWNSHIP

Quartz: (D'Invilliers, 1883, 400). *Pyrite:* radiating masses (D'Invilliers, 1883, 399).

GREAT VALLEY IRON MINES

The following minerals have been noted in the numerous iron-ore pits in the limestone valley north of the Reading Hills. Residual deposits of goethite and limonite.

Quartz: drusy, coating goethite (D'Invilliers, 1883, 400). *Calcite:* (D'Invilliers, 1883, 395). *Goethite:* fibrous radiating, geodic (D'Invilliers, 1883, 297). *Turgite:* coatings on goethite, often iridescent (Genth, 1875, 47). *Pyrolusite:* on goethite (Genth, 1875, 46). *Psilomelane, wad:* (Genth, 1875, 53).

BLAIR COUNTY

BELLWOOD.[105] One mile north of Bellwood Station, on the west branch of the Juniata, at the foot of the western slope of Brush Mountain. Helderberg? limestone.

Quartz: colorless crystals (Dana, 1868, 779). *Dolomite:* (Dana, 1844, 255). *Anhydrite:* (Dana, 1844, 255). *Celestite:* pale blue fibrous layers, of varying thickness up to one inch. Specimens were first collected by Schütz in 1791; it was analyzed by Klaproth[106] and named Coelestin by Werner in 1798.

KEYSTONE ZINC MINES. In the Sinking Valley, 1/2 mile southwest of Birmingham. Helderberg? limestone; hydrometamorphic deposits.

Galena: (Genth, 1875, 11). *Sphalerite:* (Platt, 1881, 258). *Pyrite:* (Eyerman, 1889, 5). *Smithsonite:* granular masses (Genth, 1875, 161). *Cerussite:* massive (Genth, 1875, 163). *Calamine:* (Genth, 1876, 106). *Barite:* (Eyerman, 1889, 41).

KINCH'S FARM. In the Sinking Valley, 1/2 mile southwest of Birmingham. Helderberg? limestone.

Barite: (Platt, 1883, 272).

COL. GALBRAITH'S LAND. In the Sinking Valley, 2 miles south of Birmingham. Helderberg? limestone.

Barite: cellular, reddish-gray (McCreath, 1879, 369; analyses).

WILLIAMSBURG.

Celestite: prismatic crystals, faintly bluish, measuring 2 cm. in length.

BRADFORD COUNTY[107]

BARCLAY. In the shingle of Big Schroeder and its side ravines, and on Rollinson Run, about 4 miles southwest of Barclay, Barclay township. Pocono sandstone.

Pyrolusite: masses, residual weathering product. (Platt, 1878, 124).[108]

CARPENTER MINE. Near New Albany, on a small branch of Towanda Creek, 1/2 mile north of the Penna. R. R. and canal. Gray Devonian shales; hydrometamorphic veins.

Tenorite: (Weed, 1911, 59). *Melaconite:* (Weed, 1911, 59). *Chalcocite:* (Weed, 1911, 59). *Cerussite:* (Weed, 1911, 59). *Malacite:* (Weed, 1911, 59).

[105] Young, 1875, 127, Platt, 1881, 128. The locality has been variously given as Bald Eagle Mt.; Baley Mountains; Frankstown, Huntingdon County; Logan's Valley; Alexandria; and Raystown.

[106] Klaproth, 1797, 92; see Seybert, 1808, 260. Mügge, 1889, 187, described some material as pseudomorphous after gypsum.

[107] Galena occurs in minute quantities associated with pyrite in Carboniferous sandstone (Genth, 1875, 11).

[108] Wad was reported by Cleaveland (1816, 548) on the East Branch of the Susquehanna, where it enters Pennsylvania.

BUCKS COUNTY

Bensalem Township

Trevose. Cut on the New York Short Line, P. & R. Ry., about 1/4 mile east of Trevose Sta. Wissahickon gneiss.

Almandite: dodecahedra (Benge and Wherry, XIII, 1906, 21).

Hulmeville. Abandoned quarry on Neshaminy Creek, opposite Hulmeville, about 1 1/2 miles S. of Langhorne Sta., P. & R. Ry. (Trenton 7256). Wissahickon gneiss and granitic pegmatite.

Pegmatite, primary: *Muscovite:* crystals (Benge and Wherry, XIII, 1906, 23). *Almandite:* crystals (Benge and Wherry, l. c.). *Tourmaline:* black crystals (Vanartsdalen, 1902, 42). *Cyanite:* (Benge and Wherry, l. c.)

Taylor's Woods.[109] Exposure in Taylor's Woods, south of Neshaminy Creek, 1 1/2 miles east of Neshaminy Falls Sta., P. & R. Ry. (Trenton 7218). Meta-peridotite and meta-pyroxenite.

Primary: *Enstatite?* (Benge and Wherry, XIII, 1906, 23).

Hydrothermal metamorphs: *Anthophyllite:* (Eyerman, 1911, 5; analysis). *Chlorite:* (Benge and Wherry, l. c.). *Magnetite:* (Benge and Wherry, l. c.).

Flushing. Exposures along Rodman's Run, west of Flushing; about 1 1/2 miles north of Croydon Sta., P. R. R. (Trenton 7289). Meta-peridotite and pyroxenite.

Primary: *Enstatite:* (Eyerman, 1889, 15).

Hydrothermal metamorphs: *Anthophyllite?* (Vanartsdalen, 1902, 42). *Actinolite:* (Benge and Wherry, XIII, 1906, 23). *Amphibole asbestus:* (Benge and Wherry, l. c.). *Serpentine:* lamellar (Carpenter, 1828, 12). *Talc:* (Benge and Wherry, l. c.). *Magnetite:* octahedra (Benge and Wherry, l. c.).

Weathering product: *Quartz:* drusy; colorless or green (Vanartsdalen, 1902, 42). (Benge and Wherry, l. c.).

Buckingham Township

Bycot. Paxon's quarry, about 1/2 mile S. W. of Bycot Sta., P. & R. Ry. Shenandoah (Cambro-ordovician) limestone.

Chert, flint: (Benge and Wherry, XIII, 1906, 9). Also occurs in an abandoned quarry about 3/4 of a mile north of Bycot Station. *Fluorite:* purple crystals (Benge and Wherry, l. c.).

Buckingham Mountain.

Quartz: crystals; occurs at an exposure on the northwest slope of Buckingham Mountain, about 1 mile S. W. of Bycot Sta. in Cambrian sandstone. *Wad:* occurs at an old umber mine, on the south slope of Buckingham Mountain at curve of road about 1/2 mile south of Bycot Station.

Bushington. Exposure about 1/2 mile N. E. of Bushington, on the road to Centreville. Triassic shales, hydrothermal veins.

Barite: (Benge and Wherry, XIII, 1906, 9).

Buckingham. Roadside exposure about 1 mile E. of Buckingham Sta., P. & R. Ry., on the road to Pineville. Triassic shales, hydrothermal veins.

Barite: (Benge and Wherry, XIII, 1906, 9).

Bristol Township

Newportville. Exposure above dam and near mill at Newportville, on Neshaminy Creek, 2 miles north of Croydon Sta., P. R. R. Wissahickon gneiss and granitic pegmatite.

Pegmatite, primary: *Microcline:* cleavage masses (Carpenter, 1828, 12). *Muscovite:* (Benge and Wherry, XIII, 1906, 23). *Biotite:* (Benge and Wherry, l. c.). *Almandite:* crystals (Benge and Wherry, l. c.). *Tourmaline:* (Vanartsdalen, 1902, 42).

East of Newportville.

Quartz: crystals occur in a hillside exposure, 1 mile northeast of Newportville (Benge and Wherry, XIII, 1908, 108). *Ilmenite:* large fragments are abundant in the Pensauken clays and gravels, 1/4 mile east of Newportville (Vanartsdalen, 1902, 43).

[109] Oakford of Eyerman (1911, 5).

Doylestown Township

Edison. Turnpike quarry, 1/4 mile west of Edison (Bridge Point) about 2 miles south of Doylestown. Triassic shales.

Calcite: hydrometamorph (Benge and Wherry, XIII, 1906, 9).

Durham Township

Durham. Jasper quarry near Durham. Cambrian quartzite.

Chalcedony; jasper: (Benge and Wherry, XIII, 1906, 8). *Hematite:* red, occurs near Durham (Genth, 1875, 34).

Rockhill Trap Quarry. East of Rockhill Sta., P. & R. Ry. Triassic intrusive diabase.

Primary: *Pyroxene:* (Benge and Wherry, XIV, 1907, 42).

Hydrothermal metamorphs: *Hornblende:* (Benge and Wherry, l. c.). *Calcite:* (Benge and Wherry, l. c.). *Prehnite:* light green (Benge and Wherry, l. c.; Eyerman, 1911, 8, analysis).

East Rockhill Township

Keelersville. Roadside exposure 1 1/2 miles S. W. of Keelersville. Triassic shales.

Pyrite: (Benge and Wherry, XIII, 1906, 8). *Malachite:* (Benge and Wherry, l. c.).

Josiah Diehl's Farm. One-half mile northwest of Rockhill Sta., P. & R. Ry. Triassic shales. Gold was reported as occurring in the shales, but the report was later discredited (Benge and Wherry, XIII, 1906, 8 and 109).

Stilbite: small yellowish-white thin tabular crystals (Benge and Wherry, l. c.; Eyerman, 1911, 11, analysis). *Heulandite?* (Benge and Wherry, l. c.).

Rockhill. Cut, 1/4 mile south of Rockhill Sta., P. & R. Ry. Triassic diabase.

Hydrothermal metamorphs: *Prehnite:* (Benge and Wherry, XIV, 1907, 42). *Stilbite:* (Benge and Wherry, l. c.).

Falls Township

Morrisville. Quarry on hillside, west of canal, north of the Trenton Bridge. (Trenton 5732). Cambrian (Chickies) quartzite. Idle.

Quartz: blue (Seybert, 1808, 156; Benge and Wherry, XVII, 1906, 23). *Tourmaline:* (Benge and Wherry, l. c.). *Martite:* minute octahedra (Benge and Wherry, l. c.).

Dana's Farm. Northwest of Morrisville, west of the canal. (Trenton, 5731). Baltimore gneiss.

Albite: crystalline cleavage masses (Hall, 1881, 101, analysis by Genth). *Hornblende:* dark grayish-green (Hall, 1881, 102; analysis by Genth. *Biotite:* (Hall, l. c.). *Chlorite:* dark green scales (Hall, 1881, 101; analysis by Genth).

Lower Makefield Township

Mt. Eyre. Near Mt. Eyre, southeast of Dolington. Triassic shales and sandstones.

Glauberite crystal cavities: in shale (Wherry, 1916, 40).

Yardley. Farms of George DeCorcy and Henry Haviland, on the P. & R. Ry., 1 mile S. W. of Yardley Sta. Triassic shales, sandstones, and conglomerate.

Gold: traces in conglomerate (Benge and Wherry, XIII, 1906, 21).

Middletown Township

Woodbourne. Moon's quarry, about 200 yards north of Woodbourne Sta., P. & R. Ry. Gravel deposit. Inaccessible, being covered by the Trenton Cutoff R. R. embankment.

Oligoclase: (Hall, 1881, 99; analysis by Genth). *Quartz:* "cleavable" (Benge and Wherry, XIII, 1906, 21). *Opal:* red; milky and smoky (Benge and Wherry, l. c.).

Jesse Darrah's Quarry. West of Langhorne, on the road to Feastersville. (Trenton 4876). Baltimore gneiss and gabbro.

Quartz: blue (Benge and Wherry, XIII, 1906, 21). *Oligoclase:* (Benge and Wherry, l. c.). *Garnet:* massive (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.).

Cut on south branch of Trenton Cut-off R. R., just east of Neshaminy Creek, about 1½ miles west of Langhorne. Baltimore gneiss and gabbro.

Quartz: blue (Benge and Wherry, XIII, 1906, 21). *Hypersthene:* (Benge and Wherry, l. c.). *Biotite:* brown (Benge and Wherry, l. c.). *Pyrrhotite:* (Benge and Wherry, l. c.). *Hematite:* micaceous (Benge and Wherry, l. c.). These minerals were also found in the cut west of the creek in Southampton township.

GLENLAKE. Quarry in woods, about 1/4 mile S. E. of Glenlake Sta., P. & R. Ry. Cambrian (Chickies) quartzite. Idle.

Tourmaline: (Vanartsdalen, 1902, 42).

JANNEY. Quarry east of Neshaminy Creek, about 1/2 mile northwest of Janney Sta., P. & R. Ry. Cambrian (Chickies) quartzite, and Baltimore gneiss. (Trenton 7138).

Albite: (Benge and Wherry, XIII, 1906, 21). *Tourmaline:* (Benge and Wherry, XIII, 1906, 21). *Hematite:* (Benge and Wherry, XIII, 1906, 109).

EDEN. Roadside exposure, 1/2 mile northeast of Middletown cross-roads; about 1 mile east of Langhorne Sta., P. & R. Ry. Wissahickon gneiss.

Almandite: large crystals (Benge and Wherry, XIII, 1906, 22).

MT. MISERY. On Neshaminy Creek, about 1/2 mile southeast of Parkland Sta., P. & R. Ry. Wissahickon gneiss and pegmatite.

Almandite: crystals (Benge and Wherry, XIII, 1906, 22); also occurs along road 1/4 mile east of the locality. *Tourmaline:* (Benge and Wherry, l. c.).

HILCROFT. Exposure of gravel bank, north of Hilcroft Sta., Doylestown-Bristol Trolley line; about 3 miles N. W. of Bristol. Pensauken gravels.

Limonite: large masses (Benge and Wherry, XIII, 1906, 22).

NEWPORTVILLE. One-half mile above Newportville, on Neshaminy Creek. Old iron mine. Pensauken gravels.

Magnetite: (Carpenter, 1828, 12). *Limonite:* occurs 1/4 mile east of the creek (Benge and Wherry, XIII, 1906, 22).

MILFORD TOWNSHIP

STEINSBURG. Roadside exposures near school, one mile south of Steinsburg. Triassic red shales.

Glauberite crystal cavities: (Wherry, 1916, 37–43).

NEW BRITAIN TOWNSHIP

NEW GALENA. Doan's mine, on north branch of Neshaminy Creek, about 3 1/2 miles N. W. of Doylestown. (Doylestown 7316). There are a number of openings on both sides of the creek, all abandoned. Triassic shales; hydrothermal veins.

Hydrothermal veins; primary: *Quartz:* small crystals (Lyman, 1898, 421). *Dolomite:* crystals (Genth, 1875, 156). *Ankerite:* crystals (Benge and Wherry; XIII, 1906, 9; analysis by Wherry: Mineral Collector, 13, 62, 1906.) *Calcite:* crystals (Benge and Wherry, l. c.). *Gold:* in galena (Dubois and Eckfeldt, 1861, 274). *Galena:* crystals (Genth, 1875, 11). *Sphalerite:* (Eyerman, 1889, 4). *Pyrite:* (Benge and Wherry, XIII, 1906, 9). *Chalcopyrite:* (Lyman, 1898, 421). *Bornite:* (Benge and Wherry, XIII, 1906, 109).

Hydrothermal veins; hydrometamorphs: *Malachite:* (Benge and Wherry, XIII, 1906, 9). *Pyromorphite:* (Benge and Wherry, l. c.).

NOCKAMIXON TOWNSHIP

NOCKAMIXON. Exposure on east side of road just north of Nockamixon; also at roadside exposure just south of Kintnersville. Triassic shales.

Malachite: traces (Benge and Wherry, XIII, 1906, 8).

NORTHAMPTON TOWNSHIP

RUSHLAND. Railroad cut just outside of Lukens and Yerkes quarry, Rushland. Triassic shales.

Analcite: Hydrothermal metamorph in a feldspathic shale. (E. T. Wherry, priv. comm.).

HOLLAND. Hillside exposures about 1/2 mile southeast of Holland. Baltimore gneiss and gabbro.

Graphite: (Benge and Wherry, XIII, 1906, 22). *Chalcopyrite:* (Benge and Wherry, l. c.). *Malachite:* (Benge and Wherry, l. c.).

FINNEY'S QUARRY. On Mill Creek, east of Roxton; about 1/4 mile north of Holland. Idle. (Trenton 4776). Baltimore gneiss.

Quartz: blue (Benge and Wherry, XIII, 1906, 22). *Orthoclase:* (Vanartsdalen, 1902, 42; Eyerman, 1911, 3, analysis). *Albite:* (Vanartsdalen, l. c.). *Hypersthene:* (Benge and Wherry, 1906, 109). *Biotite; lepidomelane?* (Benge and Wherry, XIII, 1906, 22). *Muscovite:* (Benge and Wherry, XIII, 1906, 22). *Almandite:* red (Vanartsdalen, l. c.; Eyerman, 1911, 6, analysis). *Chlorite:* (Vanartsdalen, l. c.). *Zircon:* (Benge and Wherry, l. c.). Crystals of zircon occur in a boulder in the creek in front of the quarry. (Benge and Wherry, XIV, 1907, 42). *Molybdenite:* (Benge and Wherry, XIII, 1906, 109). *Pyrite:* (Benge and Wherry, XIII, 1906, 22). *Pyrrhotite:* (Benge and Wherry, XIII, 1906, 22). *Chalcopyrite:* (Vanartsdalen, l. c.). *Bornite:* (Vanartsdalen, l. c.). *Chalcocite:* (Vanartsdalen, l. c.). *Hematite:* crystals (Benge and Wherry, XIII, 1906, 22). *Calcite:* crystals (Benge and Wherry, XIII, 1906, 109). *Barite:* blue crystals (Benge and Wherry, XV, 1908, 108). *Malachite:* (Benge and Wherry, XIII, 1906, 22). *Azurite:* (Benge and Wherry, XIII, 1906, 22). *Chrysocolla:* (Benge and Wherry, XIII, 1906, 22). *Gypsum:* (Benge and Wherry, XIII, 1906, 22). *Hyalite:* colorless and blue (Benge and Wherry, XIV, 1908, 108).

SOLEBURY TOWNSHIP

SOLEBURY MINE. West end of Bowman's Hill, on Pidcock Creek, about 2 1/2 miles south of New Hope. Triassic shales.

Malachite: (Benge and Wherry, XIII, 1906, 8).

NEW HOPE. Trolley-cut and hillside exposures just south of New Hope, near Dark Hollow Run. Triassic shales, and intrusive diabase.

Contact metamorphs: *Epidote:* small, dark green crystals (Rogers, II, 1858, 685). *Vesuvianite:* minute wine-color crystals (Rogers, l. c.). *Andradite:* yellow crystals (Benge and Wherry, XIII, 1906, 109). *Tourmaline:* black crystals (Eyerman, 1889, 26).

REEDER. Quarry between Aquetong Creek and P. & R. Ry., about 1 mile west of New Hope. Triassic shales.

Calcite: crystals (Benge and Wherry, XIII, 1906, 8). *Epidote:* (Benge and Wherry, l. c.).

SOUTHAMPTON TOWNSHIP

PAXON'S QUARRY. West side of Neshaminy Creek, 2 miles north of Neshaminy Falls Sta., P. & R. Ry., Baltimore gneiss and gabbro. Idle.

Quartz: blue (Benge and Wherry, XIII, 1906, 22). *Oligoclase:* (Benge and Wherry, l. c.). *Biotite:* brown (Benge and Wherry, l. c.). *Graphite:* (Benge and Wherry, l. c.). *Pyrite:* (Eyerman, 1889, 5). *Pyrrhotite:* (Benge and Wherry, l. c.).

VANARTSDALEN'S QUARRY. Two miles north of Neshaminy Falls and 3/4 mile west of Neshaminy Creek, on a small run. (Trenton 4788). Abandoned. Franklin limestone, intruded by gabbro. Tactite.

Contact metamorphs. *Quartz:* blue, massive; rarely in crystals (Morton, 1829, 48). *Orthoclase? necronite:* fetid, with black inclusions (Lea, 1866, 112). *Microcline:* whitish, gray, dark blue to black; cleavage masses (Morton, 1829, 48; Rand, 1867, 186; 1871, 300; Genth, 1875, 94; 1876, 225, analysis; Eyerman, 1911, 3, analysis). *Pyroxene: diopside, coccolite, salite, augite, fassaite:* (Morton, 1829, 48; Rogers, II, 1858, 712, Rand, 1867, 185; Genth, 1875, 65; Eyerman, 1911, 4, analysis of diopside). *Amphibole; actinolite, tremolite:* (Carpenter, 1828, 13). *Wollastonite:* fibrous, translucent, masses (Morton, 1829, 46, analysis). *Wernerite:* massive; greenish-white translucent crystals (Morton, 1829, 48; Rand, 1867, 186; Leeds, 1870, 62; 1873, 26, analysis; Eyerman, 1911, 7, analysis). *Muscovite?* green (Dana, 1850, 654; Genth, 1875, 85; Rand, 1892, 183). *Phlogopite:* brown, green, silver-white (Morton, 1829, 48; Vanartsdalen, 1902, 186). *Apatite:* bluish hexagonal crystals and grains (Morton, 1829, 49; Genth, 1875, 139). *Zircon:* rarely in brown prismatic crystals (Morton, 1829, 48; Genth, 1875, 76). *Titanite:* brown tabular crystals up to one inch square (Morton, 1829, 49). *Rutile:* (Rogers, II, 1858, 712). *Graphite:* hexagonal plates (Morton, 1829, 49; Genth, 1875, 10). *Pyrite:* octahedra up to 2 inches thick (Morton, 1829, 49). *Pyrrhotite:* (Genth, 1875, 17).

Hydrometamorph: *Calcite:* crystals (Rand, 1867, 185).

Weathering products: *Limonite:* (Benge and Wherry, XIII, 1906, 22). *Malachite:* near the spring (Vanartsdalen, 1902, 186). *Gypsum*: efflorescences resulting from the action of oxidizing pyrite on the limestone (Genth, 1875, 148).

SILES. Roadside exposure about 1/8 mile N. W. of Siles P. O. (Scottsville); about 1 mile N. W. of Neshaminy Falls. Baltimore gneiss.

Zircon: small crystals (Benge and Wherry, XIII, 1906, 22–23).

NESHAMINY FALLS. Exposures of Cambrian sandstone.

Tourmaline: (Vanartsdalen, 1902, 42). *Ilmenite:* (Vanartsdalen, l. c.).

Exposures in a field on the west side of Neshaminy Creek, about ½ mile north of Neshaminy Falls. Baltimore gneiss.

Quartz: blue (Benge and Wherry, XIII, 1906, 23). *Zircon:* crystals (Benge and Wherry, 1906, 23; Wherry, 1908, 70). *Titanite:* crystals (Benge and Wherry, l. c.).

JOHNSON'S GRAPHITE MINE. About 1/2 mile north of Trevose Sta., P. & R. Ry. Baltimore gneiss. This mine has long been abandoned, and the dumps are well overgrown.

Quartz: blue (Benge and Wherry, XIII, 1906, 23). *Orthoclase:* (Benge and Wherry, l. c.). *Graphite:* (Eyerman, 1889, 3).

KNIGHT'S QUARRY. About 1/4 mile north of P. & R. Ry., about 1/2 mile west of Trevose Sta. Cambrian (Chickies) quartzite. Idle. (Trenton, 7914).

Rutile? crystals (Benge and Wherry, XIII, 1906, 23).

FEASTERVILLE. Exposure at forks of road, 1/4 mile north of Feasterville. Baltimore gabbro. (Germantown, 6368).

Hypersthene: (Benge and Wherry, XIII, 1906, 23).

SPRINGFIELD TOWNSHIP

BURSONVILLE. Roadside exposure, 3/4 mile S. E. of Bursonville. Triassic red sandstone.

Chalcopyrite: traces (Benge and Wherry, XIII, 1906, 8).

TINICUM TOWNSHIP

UHLERTOWN. Jacob Tettemer's farm, 1 mile N. W. of Uhlertown, near Upper Tinicum Church. Abandoned mine, and roadside exposures. Triassic shales.

Chalcocite: (Benge and Wherry, XIII, 1906, 8). *Malachite:* (Benge and Wherry, l. c.).

UPPER MAKEFIELD TOWNSHIP

BUCKMANVILLE. Old barite mine on the New Hope-Pineville Road, about 1 mile west of Buckmanville. (Trenton 4146?). Triassic shales and intrusive diabase; hydrothermal veins.

Quartz: crystals (Benge and Wherry, XIII, 1906, 109). *Barite:* small tabular crystals (Benge and Wherry, XIII, 1906, 109). *Chalcopyrite:* (Benge and Wherry, XIII, 1906, 109). *Malachite:* (Benge and Wherry, XIII, 1906, 10).

WARWICK TOWNSHIP

GRENOBLE. Quarry at Ross's Mill, about 1/4 mile west of Grenoble Sta., P. & R. Ry. Triassic shales.

Calcite: crystals in hydrometamorphic veins (Benge and Wherry, XIII, 1906, 10).

WEST ROCKHILL TOWNSHIP

SELLERSVILLE.

Chalcopyrite: (Eyerman, 1889, 45). *Azurite:* (Eyerman, 1889, 45). *Malachite:* (Eyerman, 1889, 45).

PERKASIE. Exposures along the Chestnut Hill-Allentown Trolley line, about 1 1/2 miles N. W. of Perkasie. Triassic shales and intrusive diabase.

Epidote: nodules, contact metamorph (Benge and Wherry, XIV, 1907, 42).

WRIGHTSTOWN TOWNSHIP

WRIGHTSTOWN. Washout along creek, 1/2 mile south of Wrightstown. Triassic shales

Pyrite: crystals (Benge and Wherry, XIII, 1906, 10).

Bucks County in General

Baltimore gneiss areas: *Quartz:* blue quartz is abundant in the ridge of Baltimore gneiss (Buck Ridge) which extends in a northeasterly direction from Southampton, through Middletown and Lower Makefield townships. The inclusions in the quartz have been studied by Bilgram and Keeley (1903, 700). *Graphite:* is locally abundant in the Baltimore gneiss (Cleaveland, 1816, 404).

Wissahickon gneiss areas: *Almandite:* rough crystals are abundant in the Wissahickon gneiss (Benge and Wherry, XIII, 1906, 24).

Chickies quartztite: *Tourmaline:* small brilliant crystals occur in the belt of Chickies quartzite flanking Buck Ridge on the south. *Martite:* octahedra, of frequent occurrence (Benge and Wherry, l. c.).

Triassic shales: *Epidote:* nodules are locally abundant, notably in Nockamixon township, where the shales have been metamorphosed by intrusions of diabase. *Malachite:* traces of malachite are very common in the shales (Lyman, 1898, 416). *Silicified wood:* the following occurrences of silicified wood in the Triassic are listed by Wherry (1912, 366–379).

1. Roelofs: DeCourcey's farm, 1/4 mile S. of station.
2. Woodbourne: farms 1 1/2 mile N. of Station.
3. Newtown: bed of Neshaminy Creek, 1 1/2 miles W. of station.
4. St. Leonards: roadside exposure N. E. of station.
5. Holland: fields S. and S. E. of station, and along the north bank of Mill Creek.
6. Churchville: fields E. of station.
7. Center Hill: fields along ridge just N. W. of village and for two miles southwestward.
8. Spring Valley: fields 1 mile southwest of.
9. Doylestown: fields 1 1/2 mile south of the town.

Triassic diabase: *Gold:* traces of gold are present in the Rock Hill belt, and in the sand formed by its decomposition (Benge and Wherry, XIII, 1906, 110).

Pensauken gravels: *Quartz:* rock-crystal, smoky, milky, drusy; chalcedony, flint, jasper, agate and basanite have been noted in the Pensauken gravels of Bensalem, Bristol, Falls, Lower Makefield, and Middletown townships.

CARBON COUNTY

Mauch Chunk. Cut of electric railroad at the eastern termination of Mount Pisgah, about 3/4 of a mile north of Mauch Chunk. Pottsville conglomerate.

Hydrometamorphs: *Carnotite:* yellow, scattered streaks and patches in the lower portion of a coarse grained conglomerate (containing fragments of quartz, with much hornblende and biotite), just above the red Mauch Chunk (Mississippian) shale. (Wherry, 1912, 574; 1914, 147; analyses). *Torbernite?* (Eyerman, 1911, 23).

Burning Mine, Summit Hill.

Kaolinite: (Johnson and Blake, 1867, 354; analysis). *Sulfur:* minute crystals and pulverulent coatings have been met with in several mines (Genth, 1875, 7). It is very probable that the material is copiapite. *Sal ammoniac:* minute dodecahedra, crystalline crusts and fibrous masses, white or yellowish-white; frequently colored yellow by ferric chloride (Genth, 1850, 28).

Nesquehoning. No. 1 Tunnel on Rhume Run, 1/2 mile south of Nesquehoning. The following minerals occur on the roof and sides of the tunnel about 2000 feet from the entrance, adjacent to the "Fifty Foot Vein." Carboniferous sedimentary rocks.

Lansfordite: white, transparent stalactites with crystalline faces at the extremities. Rapidly alter to chalk-white, opaque nesquehonite, so must be kept in petroleum oil (Genth, 1889, 255; Genth and Penfield, 1890, 121; Federov, 1909, 299; Cesaro, 1910, 261). *Nesquehonite:* colorless or white; minute prismatic crystals, usually in radiating groups; also pseudomorphous after lansfordite (Genth and Penfield, 1890, 121).

Lansford.

Halotrichite: acicular crystals, radiating aggregates.

CENTER COUNTY

Quartz: crystals, on Buffalo Run, Patton township (Eyerman, 1889, 13). *Goethite:* fibrous masses, formerly mined at a number of localities throughout the county, where it occurs

with limonite and psilomelane, as residual deposits (Genth, 1875, 50). *Limonite:* (Genth, 1875, 50). *Psilomelane:* (Genth, 1875, 53).

CHESTER COUNTY

Birmingham Township[110]

Pocopson. Exposures in field northwest of Minshall Painter's house, 1/4 mile east of Pocopson Sta., Wilmington & Northern Br., P. & R. Ry. Wissahickon gneiss; quartz veins.

Amethyst: containing rutile (Eyerman, 1889, 14; Benge and Wherry, XV, 1908, 54).

Osborn Hill. Abandoned mine[111] and exposures on the west slope of Osborn Hill, 2 1/2 miles south of Westchester. Wissahickon gneiss; pegmatite.

Quartz: limpid and smoky crystals in the soil (Carpenter, 1828, 4). *Orthoclase:* crystals on the west side of the hill (Jefferis, 1892, 190). *Anthophyllite?* (Benge and Wherry, XV, 1908, 54). *Actinolite:* (Dana, 1850, 654). *Hornblende:* acicular, fibrous (Carpenter, 1828, 4). *Spessartite:* reddish-brown; massive; minute crystals (Carpenter, 1828, 4). *Tourmaline:* black crystals in quartz (Carpenter, 1828, 4). *Titanite:* yellow, in massive spessartite (Dana, 1850, 654). *Calcite:* fetid (Dana, 1850, 654). *Pyrolusite:* weathering product on gneiss (McKinstry, priv. comm.). *Wad:* massive, brown; weathering product (Carpenter, 1828, 4).

Brandywine Battlefield.

Beryl: in pegmatite (Genth, 1875, 71).

Charlestown Township[112]

Charlestown Mine. Just west of Pickering Sta., P. R. R. (Phoenixville 6835). Inaccessible. Triassic shales; hydrothermal veins. The same minerals were found at the Buckwater mine to the west (Phoenixville 6824).

Hydrothermal veins; primary: *Calcite:* (Benge and Wherry, XV, 1908, 7). *Quartz:* (Dana, 1868, 777). *Galena:* (Dana, l. c.).

Hydrothermal veins; hydrometamorphs: *Cerussite:* (Dana, l. c.). *Pyromorphite:* (Dana, l. c.).

Devault. Quarries near Devault Sta., P. R. R. Shenandoah limestone; hydrometamorphic veins.

Quartz: crystals (Benge and Wherry, XV, 1908, 8). *Dolomite:* crystals (Benge and Wherry, l. c.).

East Bradford Township[113]

Copesville.[114] Exposures near Copesville, on the Brandywine Creek, and in the banks, gutters, and fields for a mile along the road to West Chester. Wissahickon gneiss and pegmatite.

Albite: white, laminated (Genth, 1875, 91). *Cyanite:* green, blue, and gray prismatic crystals (Carpenter, 1828, 4; Eyerman, 1911, 7, analyses). *Muscovite:* green (Carpenter, 1828, 6). *Apatite:* occurs in a quarry on the creek road (McKinstry).

Minorcus Hill. Fields on the northwest slope of Minorcus Hill, 1/2 mile northeast of Copesville. Wissahickon gneiss; pegmatite.

Albite: (Benge and Wherry, XV, 1908, 28). *Almandite:* (Benge and Wherry, l. c.). *Cyanite:* green, blue, gray (Dana, 1850, 654). *Tourmaline:* (Benge and Wherry, l. c.). *Allanite:* (Dana, 1854, 488). *Apatite:* (Dana, 1850, 654).

Black Horse Inn. Roadside exposures about 75 yards west of the old Black Horse Inn, 2 miles west of West Chester. Wissahickon gneiss; pegmatite; and meta-peridotite.

Wissahickon gneiss: *Cyanite:* green, blue, and white (Carpenter and Spackman, 1826, 220). *Rutile:* occurs 100 yards east of the Inn (Dana, 1850, 654). *Titanite:* (Carpenter and Spackman, 1826, 220).

[110] Calcite in "A. Darlington's lime quarry;" serpentine and cerolite were reported by Dana (1850, 654; 1868, 777).

[111] A mine was opened for silver about 1768 (Carpenter); According to Jefferis, a manganese mine was opened about 1835, and a half ton of wad was taken from a depth of 30 feet.

[113] Amethyst, graphite, and limonite occur in the township (Dana, 1892, 1067; Carpenter, 1828, 10).

[112] Tourmaline, pyrite, graphite, titanite, smoky quartz, and mussite have been reported without definite localities. (Carpenter, 1828, 5; Dana, 1850, 654; Genth, 1875, 73; Eyerman, 1889, 16).

[114] The "Buffington's Bridge," and "Cope's Mills" of earlier writers.

Peridotite; hydrothermal metamorphs: *Talc:* indurated: green, compact (Carpenter and Spackman, l. c.). *Clinochlore:* large green plates in the roadbed (McKinstry).

CALEB COPE'S QUARRY. On the West Chester-Coatesville Trolley Line, between Taylor's Run and Copeland School House (West Chester 2514). Wissahickon gneiss; Shenandoah limestone; meta-pyroxenite occurs near the quarry.

Wissahickon gneiss: *Orthoclase, necronite:* bluish or grayish cleavage masses, fetid; (Carpenter, 1828, 5; Genth, 1875, 93). *Garnet:* (Dana, 1868, 777). *Actinolite:* in quartz (Jefferis, 1892, 187). *Cyanite:* blue; formerly abundant in an old dam breast adjoining the quarry (Jefferis, 1892, 187; Finch, 1828, 18). *Epidote:* in quartz (Jefferis, 1892, 187).

Shenandoah limestone; hydrothermal metamorphs: *Dolomite?* fetid (Dana, 1868, 777). *Tremolite:* glassy, fibrous (Finch, l. c.). *Phlogopite:* (Finch, l. c.). *Rutile:* (Finch, l. c.).

Meta-peridotite; hydrothermal metamorphs: *Talc:* (Dana, 1868, 777). *Actinolite:* in talc (Dana, l. c.)

SOUTH OF COPESVILLE.[115] Exposures on the Brandywine, 1 mile south of Copesville. Baltimore gneiss.

Quartz: blue (Lea, 1818, 473). *Feldspar:* bluish, lamellar (Carpenter, 1828, 5). *Hornblende:* (Carpenter and Spackman, 1826, 220). *Zircon:* prismatic crystals in blue quartz (Lea, 1818, 473; Genth, 1875, 77). *Ilmenite:* with zircon in blue quartz boulders in the soil (Dana, 1868, 777; Genth, 1875, 36). *Scapolite:* occurs $^1/_4$ mile to the west (Carpenter and Spackman, 1826, 220).

COMLEY HALL.[116] Field northeast of Comley Hall, about $^3/_8$ of a mile east of Sconnelltown; about $1^1/_2$ miles southwest of West Chester. Pegmatite veins. (West Chester 2829).

Allanite: black masses, coated with a thick brown earthy weathering product; specimens weighing a pound have been found near the springhouse (Rammelsberg, 1850, analysis; Dana, 1868, 777; Genth, 1875, 79).

SCONNELLTOWN.[117] Farms south and southwest of Sconnelltown, between Brandywine Creek and Plum Run. Wissahickon gneiss; quartz veins; and metaperidotite dikes.

Amethyst: crystals (Carpenter, 1828, 5; Dana, 1850, 654; 1868, 777).

ENTRIKIN'S FARM. Roadside exposures at the northwest corner of cross-roads, 2 miles south of West Chester (West Chester 2919). Wissahickon gneiss; quartz veins.

Amethyst: crystals measuring an inch (Dana, 1850, 654).

EAST CALN TOWNSHIP

DOWNINGTOWN. Quarries near Downingtown Sta., P. R. R. Shenandoah limestone. *Calcite:* rhombohedra (Carpenter and Spackman, 1826, 246). *Dolomite:* (McKinstry). *Ankerite:* (Jefferis, 1892, 190).

EAST GOSHEN TOWNSHIP[118]

GOSHENVILLE. Fields near the schoolhouse at Goshenville cross-roads. Wissahickon. gneiss.

Almandite: trapezohedra and dodecahedra (Townsend, 1839, 9; Genth, 1875, 73). *Limonite* pseudo *Pyrite:* (Benge and Wherry, XV, 1908, 44).

Quarry on Edward's farm,[119] $1^1/_2$ miles northeast of Goshenville. (Phoenixville 9947); Meta-peridotite.

Serpentine: (Sharples, 1866, 272; Eyerman, 1911, 16; analyses). *Amphibole asbestus:* (Genth, 1875, 69). *Magnetite:* large masses, often showing polarity (Carpenter, 1828, 10). *Chromite:* (Benge and Wherry, XV, 1908, 44).

[115] The locality "North of Paper Mills (torn down);" and "Near Jefferis' ford" of earlier writers. McKinstry (priv. comm.) gives the locality as: "north of the summer residence of George E. Earnshaw, on hill near the edge of the woods."

[116] Formerly Amor Davis' farm; known in the literature as "East Bradford."

[117] Includes the farms of Mrs. Freeman's (formerly L. Sharples'), Mitchell (formerly Dr. Elwyn's); Enderly's (formerly Dr. Price's); William Gibbons, and Mrs. Foulke's.

[118] Amethyst and jasper have been reported from the township by Townsend (1839, 9). Carpenter (1828, 10) reported brown garnet from "A. Hoope's farm."

[119] Formerly Gorman's farm.

EAST MARLBORO TOWNSHIP[120]

LOGAN'S QUARRY. About 1 1/4 miles N. N. E. of Upland. (Coatesville, 6346). Shenandoah limestone.

Hydrothermal metamorphs: *Tremolite:* asbestiform (Dana, 1892, 1067). *Tourmaline:* yellow (Dana, 1850, 655). *Rutile:* prismatic crystals up to 10 cm. in length; (Dana, 1868, 777; Genth, 1875, 44).

NEAR LOGAN'S QUARRY. Wissahickon gneiss, and pegmatite.

Oligoclase: (Benge and Wherry, XV, 1908, 55). *Almandite:* (Dana, 1868, 777). *Staurolite:* (Dana, 1850, 655). *Cyanite:* blue bladed, in granular quartz (Dana, 1850, 655).

THOMAS WEBB'S QUARRY. On Thomas Webb's farm, about 1/2 mile west of Unionville. Meta-peridotite.

Serpentine: (Dana, 1850, 654). *Chromite:* massive (Townsend, 1839, 6).

Near Thomas Webb's Mill, 1 mile south of Unionville. Pegmatite.

Hornblende: (Carpenter and Spackman, 1826, 222). *Beryl:* small green prisms (Cleaveland, 1822, 343; Carpenter and Spackman, 1826, 222).

WILLOWDALE.[121] Washouts, and sides of a mill race, on the West Branch of Red Clay Creek, 3/4 of a mile W. N. W. of Willowdale, and 3/4 of a mile north of Street Road.

Vesuvianite: (Carpenter and Spackman, 1826, 221). *Zircon:* brownish-red crystals, loose in the gravel and sands in the sides of the mill race (Carpenter and Spackman, 1826, 221). *Rutile:* crystals (Carpenter and Spackman, l. c.). *Scapolite:* tetragonal prisms, was found in a lime quarry in the vicinity. (Carpenter and Spackman, 1826, 221).

BAILEY'S FARM.[122] One mile southwest of Willowdale, on the West Branch of Red Clay Creek. Wissahickon gneiss; pegmatite; Shenandoah limestone. Small quarries and exposures. Bailey's lime quarry is situated west of Upland in West Marlborough Township.

Quartz: fetid (Carpenter and Spackman, 1826, 222). *Orthoclase, necronite:* (Carpenter and Spackman, l. c.). *Microcline; chesterlite:* (Dana, 1868, 777). *Albite:* (Dana, 1850, 654). *Pyroxene:* white (Dana, 1892, 1067). *Tourmaline:* black, brown, yellow, green (Carpenter and Spackman, 1826, 222; Dana, 1850, 654). *Calcite:* crystals (Carpenter and Spackman, l. c.). *Lithomarge:* (Carpenter and Spackman, l. c.).

FARMS TO THE SOUTH OF BAILEY'S. Wissahickon gneiss and pegmatite.

Quartz: limpid crystals up to 14 inches in circumference (Carpenter and Spackman, 1826, 222). *Feldspar:* (Carpenter and Spackman, l. c.). *Cyanite:* green and blue (Carpenter and Spackman, l. c.). *Epidote:* yellowish-green prisms (Carpenter, 1828, 6). *Chlorite:* (Carpenter and Spackman, l. c.). *Apatite:* crystals (Carpenter and Spackman, l. c.). *Pyrite:* modified cubes (Carpenter, 1826, 222).

PUSEY'S QUARRIES. One and a half miles W. S. W. of Willowdale, and about 1/2 mile S. of Street Road. Wissahickon gneiss; Shenandoah limestone.

Hydrothermal metamorphs: *Calcite:* crystals (Benge and Wherry, XV, 1908, 55). *Dolomite:* crystals (Benge and Wherry, l. c.). *Quartz:* crystals (Benge and Wherry, l. c.). *Microcline:* crystals (Benge and Wherry, l. c.). *Tremolite:* silky-white, fibrous masses (Dana, 1850, 654; Eyerman, 1911, 5, analysis). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Rutile:* crystals (occurs also in Taylor's quarry to the east of Pusey's, and in the surrounding fields) (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Graphite:* (Benge and Wherry, l. c.).

Weathering product: *Aragonite:* (Benge and Wherry, l. c.).

MARLBORO. Exposures near Marlboro Meeting House. Wissahickon gneiss and pegmatite; metaperidotite.

Epidote: (Dana, 1850, 654). *Tourmaline:* acicular, in quartz (Dana, l. c.). *Serpentine:* (Dana, 1850, 654). *Talc:*[123] foliated, white or green (Carpenter and Spackman, 1826, 222).

[120] Cleaveland (1822, 243 and 704) reported amethyst and ilmenite from the township, without specifying the localities however.

[121] Pusey's Saw Mill of Carpenter and Spackman; given by them as 3/4 of a mile south of Street Road.

[122] John Bailey's farm; Bailey & Bros.' farm of earlier writers.

[123] Reported from "A. Marshall's and W. A. Cloud's farms."

East Pikeland Township

Kimberton. Quarry west of Kimberton Sta., P. & R. Ry., Franklin limestone.

Calcite: (Benge and Wherry, XV, 1908, 7). *Epidote:* (Benge and Wherry, l. c.). *Graphite:* (Benge and Wherry, l. c.).

Hallman. Raby's mine, and Fagley's mine, 1/8 mile north of Hallman Sta., P. & R. Ry. *Limonite "melanosiderite:"* (Benge and Wherry, XV, 1908, 7).

East Nottingham Township

Near Oxford.

Quartz: smoky (Genth, 1875, 58). *Garnet:* (Dana, 1850, 654). *Tourmaline:* black (Genth, 1875, 97). *Muscovite:* (Eyerman, 1889, 22). *Kaolinite:* (Genth, 1875, 119; analysis). *Goethite:* (Genth, 1875, 50). *Chromite:* octahedra (Genth, 1875, 40).

Amos Pugh's Farm. Two and half miles S. S. E. of Oxford (Elkton 7886). Pegmatite.

Beryl: greenish-white crystals (Genth, 1875, 71). *Tourmaline:* columnar, near mill (Genth, 1875, 97). *Muscovite:* globular aggregates of plates (Genth, 1875, 85).

Mt. Rocky Meeting House.[124] One mile N. W. of Mt. Rocky Meeting House, and three miles south of Oxford. Roadside exposures. Meta-peridotite; corundum pegmatite.

Albite: (Genth, 1875, 32). *Corundum:* crystals (Genth, 1875, 32). *Amphibole asbestus:* masses 2 feet long (Jefferis, 1892, 189). *Hallite:* dark bluish-green and yellow; micaceous crystals in nests or pockets in serpentine (Leeds, 1871, 70; Cooke, 1874, 59; Clarke and Schneider, 1891, 245; analyses).

East Whiteland Township[125]

General Trimble's Mine.[126] About 3/4 of a mile N. W. of Planebrook Sta., P. & R. Ry. Shenandoah limestone; residual deposits of goethite and limonite.

Goethite: (Benge and Wherry, XV, 1908, 27). *Limonite:* (Benge and Wherry, l. c.) *Wavellite:* minute colorless prismatic crystals, often in radiating tufts or aggregates; also in white yellowish or grayish stalactitic, botryoidal or radiating masses coated with gibbsite. (Genth, 1857, 423; 1875, 142; Hermann, 1869, 69; analysis). *Ceruleolactite:* pale bluish, greenish-blue to sky blue botryoidal incrustations of microscopic crystals (Genth, 1875, 143; analysis). *Gibbsite:* grayish pearly scales on limonite or wavellite (Dana, 1850, 654; Hermann, 1869, 68; Genth, 1857, 52; 1890, 199; analyses). *Allophane:* (Rand, 1867, 404); *Gibbsite:* (Rand, l. c.) occur a short distance to the southwest.

Knickerbocker Quarry. About 1/2 mile east of Mill Lane Sta., P. & R. Ry. Shenandoah limestone.

Aragonite: (Benge and Wherry, XV, 1908, 27).

Mill Lane. Farms[127] north of Mill Lane, P. R. R. Shenandoah limestone, and Octoraro schist.

Limonite pseudo *pyrite:* cubes (Dana, 1868, 778; Jefferis, 1892, 191; Eyerman, 1889, 6).

Elk Township[128]

Lewisville.

Almandite: trapezohedra and dodecahedra (Genth, 1875, 73). *Tourmaline:* black (Genth, 1875, 97). *Muscovite:* (Genth, 1875, 38). *Ilmenite:* (Genth, 1875, 36).

Kennett Township

Mullen's Farm:[129] One-half mile south of Kennett Square. Meta-gabbro.

Quartz: green (Benge and Wherry, XV, 1908, 69). *Epidote:* crystals loose in the soil (Dana, 1850, 654).

[124] The old meeting house stood 2 miles E. S. E. of Chrome.

[125] Dana (1868, 778) lists limpid quartz crystals from this township.

[126] "Steamboat," "White Horse" and "Whiteland" of some authors.

[127] Farms of L. Worthington, J. Hartman, Fetter's Mill, etc. Limonite pseudo pyrite occurs on nearly every farm in the township.

[128] Chromite occurs in the serpentine in the western part of the township (Genth, 1875, 40).

[129] Gause's Corner of Dana (1850, 654).

KENNETT SQUARE. Old lime quarries southwest of Kennett Square. Shenandoah limestone.

Tremolite: (Dana, 1850, 654). *Scapolite:* (Dana, l. c.). *Tourmaline:* brown (Dana, l. c.) *Phlogopite:* (Dana, l. c.). *Kaolinite:* (Genth, 1875, 119).

PIERCE'S PAPER MILL.[130] One-half mile southeast of Kennett Square, on the East Branch of Red Clay Creek. (West Chester 4892–3). Meta-gabbro.

Gabbro pegmatites: *Oligoclase:* sunstone, brilliant (Dana, 1850, 654). *Labradorite:* (Rogers, 1858, II, 710). *Hornblende:* (Benge and Wherry, XV, 1908, 69). *Epidote:* small green crystals (Dana, 1850, 654). *Zoisite:* (Dana, l. c.). *Cancrinite?* (Eyerman, 1889, 22). *Titanite:* yellow (Genth, 1875, 102).

Hydrothermal metamorphs: *Stilbite:* (Rogers, l. c.) *Chabazite:* small brownish-yellow crystals (Dana, 1850, 654). *Sillimanite:* (McKinstry) occurs in a road cut 1/4 mile south of Pierce's paper mill in Wissahickon gneiss.

CLOUD'S FARM. On a small run of the East Branch of Red Clay Creek, 2 miles S. E. of Kennett Square. (West Chester 7327). Meta-gabbro.

Gabbro pegmatites: *Oligoclase:* sunstone, brilliant reflections due to microscopic hexagonal plates (Lea, 1866, 110; Leeds, 1872, 434; Genth, 1875, 89). *Epidote:* (Genth, 1875, 78). *Titanite:* yellow crystals (Dana, 1868, 777).

Hydrothermal metamorph: *Chabazite:* reddish rhombohedra (Genth, 1875, 109).

GREGG'S FARM. Two miles southwest of Kennett Square (West Chester 7274).

Actinolite: (Dana, 1850, 654)

LONDON BRITAIN TOWNSHIP

NEVIN'S QUARRY. One mile S. E. of Landenberg, (Coatesville 9927). Shenandoah limestone and pegmatite. Two other quarries lie 1 1/4 miles to the southwest.

Pegmatite: *Orthoclase; necronite:* (Dana, 1868, 777). *Sillimanite:* grayish-white, acicular, fibrous (Dana, 1868, 779; Genth, 1875, 99). *Muscovite:* (Dana, 1850, 654). *Columbite:* black, imperfect crystals, 2 × 1 × 1/2 inches (Genth, 1875, 137). *Kaolinite:* (Dana, 1850, 654).

Limestone; hydrothermal metamorphs: *Dolomite:* (Genth, 1875, 44). *Tremolite:* (Benge and Wherry, XV, 1908, 56). *Wernerite:* (Dana, 1850, 654). *Tourmaline:* yellow and brown (Dana, 1850, 654). *Phlogopite:* (Dana, 1850, 654). *Apatite:* green crystals (Dana, 1868, 777). *Rutile:* acicular crystals (Dana, 1850, 654; Genth, 1875, 44). *Titanite:* brown crystals (Genth, 1875, 102).

Limestone; weathering product: *Aragonite:* (Dana, 1850, 654).

LONDON GROVE TOWNSHIP[131]

AVONDALE.[132] Quarries along the P. B. & W. R. R. 1/4 of a mile N. W. of Avondale; Shenandoah limestone; Wissahickon gneiss; and pegmatite.

Wissahickon gneiss: *Cyanite:* blue bladed masses (Carpenter, 1828, 9).

Pegmatite: *Quartz:* colorless and smoky; crystals up to 5 inches in diameter in the soil (Carpenter, 1828, 8). *Almandite:* dodecahedra up to 6 1/4 inches in diameter (Carpenter, 1828, 8). *Tourmaline:* black terminated crystals (Carpenter, 1828, 9). *Muscovite:* green (Carpenter, 1828, 8).

Limestone; hydrothermal metamorphs: *Tremolite:* white, radiated masses (Carpenter, 1828, 8). *Amphibole asbestus:* (Benge and Wherry, XV, 1908, 58). *Tourmaline:* brown and yellow crystals (Carpenter, 1828, 8). *Epidote:* green crystals (Carpenter, 1828, 9). *Talc?* (Carpenter, 1828, 8). *Apatite:* bottle green, transparent masses and rough crystals in the soil (Seybert, 1821, 144, analysis; Carnot, 1896, 145, analysis). Occurs also one mile southwest of Chatham (Rogers, 1858, I, 229). *Rutile:* striated prismatic crystals (Carpenter, 1828, 8).

[130] Formerly Lamborn's Mill.

[131] Augite, cyanite, titanite and hematite were reported from the vicinity of "Friend's Meeting House, London Grove" (Finch, 1828, 18; Genth, 1875, 102; Bruce, 1813, 233, and Carpenter, 1828, 9). Genth reported apatite from Penn's Meeting House (1875, 138).

[132] William Jackson's quarry; Mitchener's quarry adjoined it. Pile and Morrison's quarries, and Dr. Alison's farm were undoubtedly in this neighborhood. Other old quarries of the neighborhood are Baker's quarry, 3/8 of a mile N. W. of Baker; Storey's quarries, 3/8 of a mile N. E. of Westgrove; and Bernards' quarry, 1/4 of a mile farther north.

Limestone; hydrometamorphic veins: *Calcite:* yellow, scalenohedra and rhombohedra (Carpenter, 1828, 9). *Dolomite:* rhombohedra (Carpenter, l. c.).

Quarry at the west end of Toughkenamon Hill, just east of Avondale. Cambrian gneiss and pegmatite.

Pegmatite; primary: *Microcline:* (Benge and Wherry, XV, 1908, 55). *Almandite:* bright red dodecahedra up to 3 1/2 inches in diameter were formerly abundant (Jefferis, 1882, 58; 1892, 191). *Tourmaline:* crystals (Jefferis, 1892, 191). *Graphite:* (Jefferis, 1892, 191).

PENNA. GRANITE CO. QUARRY. Three-quarters of a mile northwest of Avondale Sta. P. B. &. W. R. R. Wissahickon gneiss; pegmatite; and Shenandoah limestone.

Pegmatite; primary: *Quartz:* crystals (Benge and Wherry, XV, 1908, 55). *Almandite:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.).

Lime quarry, nearby. Shenandoah limestone.

Limestone; hydrothermal metamorphs: *Amphibole; mountain-leather:* (Benge and Wherry XV, 1908, 55). *Tourmaline:* brown (Benge and Wherry, 1. c.).

Limestone; hydrometamorphic veins: *Calcite:* crystals (Benge and Wherry, l. c.). *Aragonite:* (Benge and Wherry, 1. c.).

WILSON'S QUARRY. Two miles N. N. E. of Avondale. (Coatesville 6918). Shenandoah limestone.

Tremolite: fibrous, radiated (Carpenter, 1828, 8).

LOWER OXFORD TOWNSHIP

Almandite: trapezohedra and dodecahedra (Genth, 1875, 73).

NEW GARDEN TOWNSHIP

TOUGHKENAMON. Quarry, 1/2 mile north of Toughkenamon Sta., P. B. &. W. R. R. Pegmatite.

Quartz: (Benge and Wherry, XV, 1908, 55). *Microcline:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Kaolinite:* (Benge and Wherry, l. c.).

PHILLIP'S QUARRIES. On Kennett Square Road, 1 mile west of Kennett Square. Shenandoah limestone.

Calcite: stalactitic, foliated, fibrous (Carpenter and Spackman, 1826, 223). *Tourmaline:* brown, translucent crystals (Carpenter and Spackman, l. c.).

SOUTH OF PHILLIP'S QUARRY. Wissahickon gneiss and pegmatite.

Almandite: (Carpenter, 1828, 6). *Tourmaline:* black (Carpenter, l. c.). *Muscovite:* (Carpenter and Spackman, 1826, 223). *Sillimanite:* grayish-white, fibrous (Carpenter, l. c.). *Apatite:* green crystals (Carpenter, l. c.).

JACKSON'S QUARRY.

Augite: in gabbro (Carpenter and Spackman, 1826, 223). *Pyrrhotite:* (Carpenter and Spackman, l. c.).

JOSHUA PUSEY'S QUARRY.

Calcite: arborescent, mammillary, botryoidal (Carpenter, 1828, 7).

BROWN'S QUARRY. On a small tributary of the East Branch of White Clay Creek, about 1 1/2 miles S. E. of Landenberg. Shenandoah limestone.

Tremolite: white, radiating (Carpenter, 1828, 7). *Apatite:* (Carpenter and Spackman, 1826, 223).

NEW LONDON TOWNSHIP[133]

NEW LONDON. One mile west of New London. Pegmatite.

Muscovite: large sheets enclosing magnetite.

NEWLIN TOWNSHIP

EDWARD'S QUARRY. Two miles N. N. E. of Upland (Coatesville 6323). Pierce's quarry lies a short distance to the northeast (Coatesville 6324). Shenandoah limestone; pegmatite.

[133] Carpenter (1828, 9) lists tourmaline and sillimanite from "Robert Hudson's farm."

Quartz: limpid crystals (Carpenter, 1828, 5). *Tourmaline:* black (Carpenter, l. c.). *Calcite:* crystals (Carpenter, 1828, 5). *Fluorite:* deep blue cubes and masses (Carpenter, l. c.). *Rutile:* crystals up to four inches in length (Genth, 1875, 44).

Northwest of Unionville. One and a half miles N. W. of Unionville.

Siderite: curved lamellar masses (Carpenter and Spackman, 1826, 221). *Pyrite:* large cubes (Carpenter and Spackman, l. c.). *Almandite:* dodecahedra in gneiss (Carpenter and Spackman, l. c.).

CORUNDUM HILL.[134] Corundum mines on Corundum Hill, about two miles N. E. of Unionville. (West Chester 1879). Other mines occur about 1/2 mile to the southwest (West Chester 4218). The mines are abandoned. Meta-peridotite; albite-corundum pegmatites (plumasite); Wissahickon gneiss.

Peridotite; primary: *Diallage?* (Dana, 1850, 654; Genth, 1875, 66). *Chromite:* (Dana, 1850, 654).

Peridotite; hydrothermal metamorphs: *Actinolite:* (Dana, 1850, 654). *Amphibole asbestus; mountain cork:* (Dana, 1850, 654). *Prochlorite:* (Dana, 1850, 654; Genth, 1873, 394; analyses; 1875, 134; Clarke and Schneider, 1891, 247, analyses). Dark green to light olive-green foliated or scaly masses; druses of minute crystals. *Clinochlore:* (Blake, 1851, 241). *Chloritoid?* (Dana, 1868, 777). *Serpentine; precious, antigorite, retinalite, picrolite:* yellow, light green to dark green (Dana, 1854, 654; Rogers, 1858, II, 711; Genth, 1875, 115; Benge and Wherry, XV, 1908, 45; Eyerman, 1911, 16, analysis). *Talc:* (Dana, 1850, 654). *Magnetite:* octahedra (Rogers, 1858, II, 711). *Hematite:* (Dana, 1850, 654).

Meta-peridotite; weathering products: *Deweylite:* (Genth, 1875, 91). *Quartz:* drusy, green (Dana, 1850, 654). *Chalcedony:* carnelian, jasper (Dana, 1850, 654; Rogers, 1858, II, 711). *Limonite:* (Benge and Wherry, XV, 1908, 45).

Plumasite; primary: *Orthoclase?* (Dana, 1850, 654). *Albite:* granular, white (Silliman, Jr., 1849, 389; analysis). *Oligoclase:* yellowish or brownish-white, granular (Smith and Brush, 1853, 211; Dana, 1854, 489; Genth, 1873, 377, analysis; Chatard, 1882, 384, analysis). *Anorthite? indianite:* (Jefferis, 1892, 88). *Margarite:* yellowish-white, faintly pink, broad foliated masses, fibrous, scaly, fine granular, or cryptocrystalline (Silliman, Jr., 1849, 380; Dana, 1850, 362; analyses; Smith and Brush, 1853, 207; Genth, 1873, 399–402, analyses; 1875, 136; 1882, 389, analysis). *Euphyllite:* pearly white, micaceous (Silliman, Jr., 1849, 381, analysis; Dana, 1850, 362, analyses; Smith and Brush, 1853, 209). *Tourmaline:* black, bluish to brownish-green; translucent to opaque; massive; small prismatic crystals in diaspore or margarite (Dana, 1850, 654; Silliman, Jr., 1849, 381; Lea, 1867, 44; Genth, 1875, 96). *Beryl?* yellow, rare (Dana, 1850, 654). *Almandite?* (Benge and Wherry, XV, 1908, 45). *Allanite?* (Dana, 1854, 489). *Zoisite; unionite:* white to yellowish-white, lamellar (Silliman, Jr., 1849, 384; Smith and Brush, 1853, 211; Brush, 1858, 69, analysis). *Muscovite; damourite; lesleyite;* white yellowish or reddish; fibrous, lamellar, scaly, granular, cryptocrystalline; pseudomorphous after corundum (Silliman, Jr., 1850, 397; Dana 1850, 363; Lea, 1867, 44; Sharples, 1869, 319; Genth, 1873, 386; 1875, 123; analyses; Smith, 1869, 254). *Pattersonite:* bluish-gray, laminated, slightly translucent (Lea, 1867, 44; Sharples, 1869, 320, analyses; Genth, 1873, 398, analysis). *Corundum:* white, brownish-gray, greenish, or blue; loose crystals up to 4 inches in length in the soil; granular masses have been found weighing several tons; most commonly occurs as gray crystals in white granular albite with black tourmaline and margarite (Seal, 1851, 267; Leeds 1873, 25, analysis; Genth, 1873, 362; 1875, 32). *Diaspore:* white, honey-yellow, fawn colored, or greenish; laminated masses; perfect splendent crystals up to 2 inches in length. A vein of corundum and margarite 14 feet long, 7 feet wide, and 54 feet deep was found 500 feet down the north slope of the hill; on one side of it was a coating of diaspore measuring 3 × 2 feet and 2 inches thick, well crystallized on the surface, with crystals 2 inches long. (Lea, 1867, 44; Brush, 1866, 268; Dana, 1868, 169, analysis; Genth, 1875, 48; Dana, 1886, 388). *Rutile?* (Benge and Wherry, XV, 1908, 45). *Spinel:* black octahedra (Genth, 1873, 369, analysis). *Ilmenite:* (Dana, 1892, 1067). *Pyrite:* (Dana, 1892, 1067). *Apatite:* (Genth, 1875, 138).

Plumasite; hydrometamorphs: *Brucite:* (Dana, 1854, 489). *Gibbsite:* small grayish-white mammillary incrustations on corundum (Seal, 1851, 267).

Plumasite; weathering products: *Jefferisite; culsageeite:* large yellowish-green plates

[134] Farms of John Lesley and J. Patterson of early writers. Commonly known as "Unionville."

(Genth, 1873, 391; 1875, 129; Jefferis, 1880, 280). *Halloysite,* "cerolite:" (Smith and Brush, 1853, 211, analysis. *Malachite:* stains on corundum (Genth, 1875, 167).

Other occurrences of corundum, margarite, tourmaline, and euphyllite have been reported on farms one mile north of Corundum Hill, and 1/2 mile south of Corundum Hill (Benge and Wherry, XV, 1908, 45).

JOHNSON AND PATTERSON'S QUARRY. One and a half-miles southwest of Northbrook Sta., P. & R. Ry., and about 1/2 mile S. E. of the corundum mines. Pegmatite. (West Chester 4224).

Microcline: (Genth, 1875, 93). *Oligoclase:* (Benge and Wherry, XV, 1908, 45). *Almandite:* brownish-red crystals (Genth, 1875, 73). *Tourmaline:* black prismatic crystals up to 6 inches in length (Genth, 1875, 96; Eyerman, 1911, 10, analysis). *Muscovite:* crystals (Genth, 1875, 85). *Biotite:* (Benge and Wherry, XV, 1908, 45).

BERYL HILL. About 1 mile west of Northbrook Sta. and 1 mile south of Glenhall Sta. (West Chester 4223). Pegmatite.

Beryl: bluish-green and yellow, crystals weighing up to 50 pounds (Seal, 1821, 39; Genth, 1875, 71). *Muscovite:* (Benge and Wherry, XV, 1908, 45). *Vermiculite:* (Benge and Wherry, l. c.).

GLENHALL.[135] Farms south of Glenhall. Wissahickon gneiss, quartz veins.

Amethyst: crystals in the soil (Carpenter, 1828, 7; Jefferis, 1880, 280; Benge and Wherry, XV, 1908, 45).

EMBREEVILLE.[136]

Beryl: green crystals (Carpenter, 1828, 5). *Muscovite:* green crystals (Carpenter, l. c.). *Pyrite:* cubes (Carpenter, 1828, 6).. *Talc?* (Carpenter, 1828, 5). *Cyanite:* (Eyerman, 1889, 27).

PENNSBURY TOWNSHIP[137]

JACOB SWAYNE'S FARM. Small abandoned quarry on Swayne's farm, about 1/2 mile south of Fairville. Wissahickon gneiss and pegmatite.

Microcline: perfect crystals up to 6 inches in length (Genth, 1875, 93). *Muscovite:* brownish or greenish crystals measuring up to 12 × 18 inches and weighing a hundred pounds. Crystals show inclusions of magnetite, hematite, quartz and garnet; often coloring the plates a brilliant red, blue or green. (Silliman, Jr., 1850, 377; Eyerman, 1911, 13, analysis; Rose, 1869, 190; Dana, 1869, 360; Genth, 1875, 38, 56; Rand, 1880, 276). *Magnetite:* reticulated dendrites in muscovite (Rose, 1869, 190; Dana, 1869, 360; Genth, 1875, 38; Rand, 1880, 276). *Quartz:* microscopic crystals enclosed between plates of muscovite (Genth, 1875, 56; Rand, 1880, 276). *Gahnite:* green crystals in muscovite (E. T. Wherry).

FAIRVILLE. Exposures on west side of road just south of Fairville. Meta-gabbro.

Oligoclase: sunstone (Dana, 1868, 778).

DILWORTH'S FARM. About 1/2 mile north of Fairville. Abandoned quarry, overgrown. Wissahickon gneiss and pegmatite.

Muscovite: crystals 6 inches in diameter; occur also in the soil northwest of the house, near the woods (Dana, 1850, 654; Jefferis, 1892, 190). *Almandite:* icositetrahedra (McKinstry).

MARSHALL'S FARM. Just east of Dilworth's farm. Pegmatite.

Muscovite: long striated plates (Genth, 1875, 84). *Biotite:* (Neminarz, 1874, 241, analysis; Genth, 1875, 83).

CRAIG'S FARM. About 1 mile northeast of Fairville. Wissahickon gneiss and pegmatite.

Muscovite: (Dana, 1868, 778). *Almandite:* brown crystals up to an inch in diameter, often flattened between plates of muscovite: (Dana, 1850, 654; 1868, 778; Genth, 1875, 73).

MENDENHALL'S QUARRY. About 1 mile southwest of Chadd's Ford. Shenandoah limestone; Wissahickon gneiss.

Quartz: fetid (Dana, 1868, 778). *Orthoclase; necronite:* (Carpenter, 1828, 5). *Oligoclase, sunstone?* (Dana, 1868, 778). *Tremolite:* white, acicular, radiating (Carpenter, 1828, 220). *Calcite:* crystals, lamellar masses (Carpenter, l. c.).

[135] Farms of George Passmore (Carpenter) and W. Hayes (Jefferis).

[136] "Near William Embrie's Malt House" of Carpenter. The actual locality may be Beryl Hill. Townsend (1839, 7) and Carpenter and Spackman (1826, 221) listed prehnite, feldspar, limonite, chalcedony, chromite, muscovite, quartz, talc, and tourmaline from the "serpentine ridge."

[137] Carpenter and Spackman (1826, 220) listed microcline and amethyst crystals from "Twaddle's Tavern." Dana (1868, 778) lists agalmatolite without any specific locality.

HARVEY'S QUARRY.[138] On the west side of Brandywine Creek, near Brinton's Bridge, about 1 1/2 miles N. W. of Chadd's Ford. Shenandoah limestone.

Chondrodite: orange and yellow grains (Finch, 1828, 17; Genth, 1875, 95).

CALEB BRINTON'S QUARRY. Near Harvey's quarry. Wissahickon gneiss and pegmatite.

Quartz: smoky (Benge and Wherry, XV, 1908, 70).

BURNETT'S QUARRY. Along the road, about 1/4 mile N. W. of Brinton's quarry. Abandoned and overgrown. Shenandoah limestone.

Pyroxene; diopside, salite, coccolite, mussite, and *augite:* (Finch, 1828, 17; Genth, 1875, 65; Carpenter and Spackman, 1826, 220). *Hornblende:* (Finch, 1828, 17). *Titanite:* brown crystals, an inch long (Carpenter and Spackman, 1826, 220; Genth, 1875, 102).

POPCOPSON TOWNSHIP

NORTHBROOK. Explosures near Marshall's Mill, about 1/2 mile northeast of Northbrook Sta., P. & R. Ry. Meta-peridotite.

Serpentine: (Benge and Wherry, XV, 1908, 45). *Chromite:* (Benge and Wherry, l. c.).

CORRINE. Quarry about 1 mile southwest of Corrine, just south of the West Chester-Kennett Square Trolley Line. Meta-peridotite.

Serpentine; picrolite: (Benge and Wherry, XV, 1908, 45). *Chromite:* (Benge and Wherry, l. c.).

LENAPE. Lane east of Townsend Walter's house, 1/4 mile northwest of Lenape. Wissahickon gneiss and pegmatite.

Tourmaline: slender black crystals in quartz (McKinstry).

TRUMAN LLOYD'S FARM (formerly Entrikin's) adjoining Walter's farm. Wissahickon gneiss, quartz veins.

Amethyst: crystals in the soil (Dana, 1868, 778).

POCOPSON. Darlington's farm, about 1/4 mile west of Pocopson Sta., P. & R. Ry.; and the bed of Pocopson Creek, about 1/4 mile west of Darlington's farm. Wissahickon gneiss, and quartz veins.

Amethyst: crystals in the soil (Carpenter, 1828, 5; Dana, 1868, 778). *Cyanite:* (Benge and Wherry, XV, 1908, 46).

SADSBURY TOWNSHIP

Fields along the south slope of hill in the northern part of Parkesburg, and locally for 7 miles along the valley. Shenandoah limestone; Chickies quartzite, and pegmatite.

Quartz: milky crystals; *amethyst:* clusters of small light purple crystals (Benge and Wherry, XV, 1908, 26; Genth, 1875, 57; Dana, 1850, 654). *Rutile:* deep red twinned crystals up to a pound in weight, in the soil (Townsend, 1839, 7; Dana, 1868, 778; Gratacap, 1912, 94; Jefferis, 1892, 191).

Roadside exposures between Parkesburg and Sadsburyville. Chickies quartzite; pegmatite.

Quartz: milky, *amethyst:* (Dana, 1850, 654; 1868, 778). *Tourmaline:* (Dana, 1850, 654). *Epidote:* (Dana, 1850, 654).

SADSBURYVILLE. Quarry west of Sadsburyville.

Orthoclase: (Benge and Wherry, XV, 1908, 26). *Epidote:* (Benge and Wherry, l. c.).

POMEROY. Cut on P. R. R. northeast of Pomeroy Sta. Chickies quartzite.

Rutile: (Benge and Wherry, XV, 1908, 26).

SCHUYLKILL TOWNSHIP

PHOENIXVILLE TUNNEL. Tunnel of P. & R. Ry. about 1/2 mile north of Phoenixville Sta. Triassic shales; hydrothermal veins.

Quartz: colorless, milky and smoky (Dana, 1844, 545; Genth, 1875, 58). *Calcite:* crystals (Dana, 1844, 545; Genth, 1875, 153). *Ankerite:* yellowish-white, curved rhombohedra; crystalline or granular masses (Dana, 1844, 545; 1877, 290, analysis). *Pyrite:* (Dana, 1850, 654). *Sphalerite:* (Dana, 1850, 654). *Brookite:* crystals on quartz (Dana, 1844, 545). *Octahedrite?* (Benge and Wherry, XV, 1908, 8).

MORRIS MINE.[139] One mile south of Phoenixville. (Phoenixville 6652).

[138] "Way's Hill" of Finch.

[139] Chrisman's mine?

Barite: (Dana, 1850, 654; Rand, 1867, 404). *Chalcopyrite:* (Dana, l. c.; Genth, 1875, 21). *Galena:* cubo-octahedra. *Cerussite:* (Dana, l. c.). *Anglesite:* (Dana, l. c.). *Pyromorphite:* (Dana, l. c.).

WHEATLEY MINES.[140] One-quarter mile southwest of William's Corner, 2 miles south of Phoenixville. (Phoenixville 6924). The Chester County mine adjoined it on the west (Phoenix. 6915); the Montgomery mine to the northwest (Phoenix. 6914); and the Brookdale mine on the southwest, distant about 1/2 mile (Phoenix. 6943). Pickering gneiss; Triassic red shales; intrusive diabase; hydrothermal veins.

Hydrothermal veins; primary: *Quartz:* colorless to milky crystals; cellular; pseudomorphous after calcite. (Dana, 1850, 654; Rogers, 1858, II, 701; Rand, 1867, 403; Groth, 1900, 147). *Calcite:* crystals up to eight inches in length, and an inch thick; hexagonal prisms terminated by rhombohedra were found in slabs of crystals measuring 10 feet square. Scalenohedra often occurred arranged spirally, with a cube of fluorite at the apex of each crystal, or enclosed within the termination; or with pyrite crystals arranged symmetrically on the rhombohedron. (Smith, 1855, 251; Genth, 1875, 153). *Dolomite:* (Rand, 1867, 403). *Ankerite:* curved rhombohedra, or yellowish-white granular masses (Rand, 1867, 403; Genth, 1875, 157, analysis). *Siderite:* spherosiderite: (Rogers, 1858, II, 701). *Fluorite:* colorless to pale yellowish-white; cubes, with occasional tetrahedra (Dana, 1854, 489; Smith, 1855, 251, analysis; Genth, 1875, 29). *Barite:* white laminated masses (Dana, 1854, 489; Genth, 1875, 146). *Galena;* argentiferous: cubes, cubo-octahedra, octahedra, massive, fibrous, or granular (Dana, 1850, 654; Smith, 1855, 248; Rand, 1867, 402. The lead and silver antimonial sulfuret of Rogers, 1858, II, 701, is probably a variety of galena according to Genth, 1875, 11). *Sphalerite:* pale brown, large modified and twinned dodecahedra (Townsend, 1839, 9; Smith, 1855, 250, analysis). *Gersdorffite:* cubes, modified by octahedral or dodecahedral faces; incrustations of small crystals with galena, sphalerite, quartz, and anglesite (Genth, 1859, 248). *Pyrite:* (Rogers, 1858, II, 701). *Chalcopyrite:* auriferous; crystals (Dana, 1854, 489; Smith, 1855, 249; analysis; Genth, 1875, 2). *Bournonite?* (Eyerman, 1911, 22). *Hematite:* micaceous (Genth, 1875, 34).

Hydrothermal deposits; weathering products: *Sulphur:* minute pale yellowish-green highly modified pyramidal crystals, 1 mm. in size with galena and anglesite (Smith, 1855, 253; Genth, 1875, 7; Fletcher, 1880, 187; Busz, 1889, 620). *Silver:* (Rogers, 1858, II, 701). *Copper:* sheets of arborescent crystals; delicate films on limonite, quartz, or chalcopyrite, or enclosed within crystals of anglesite (Smith, 1855, 249; Genth, 1875, 5). *Cuprite; chalcotrichite:* (Rand, 1867, 403). *Chalcocite:* (Genth, 1875, 16), probably a hydrometamorph. *Covellite:* (Genth, 1859, 248). *Melaconite:* pulverulent, massive (Rogers, 1858, II, 701; Genth, 1875, 31). *Goethite:* (Genth, 1875, 48). *Limonite:* (Smith, 1855, 251, analysis). *Aragonite:* groups of crystals (Genth, 1875, 162). *Smithsonite?* silky tufts (Rogers, 1858, II, 701). *Cerussite:* colorless, white, yellow, or black; crystals commonly twinned; sometimes coating anglesite or pseudomorphous after it (Dana, 1850, 654; Blake, 1852, 116; Smith, 1855, 245; Rand, 1867, 403; Genth, 1875, 163; Rogers, 1902, 133). *Malachite:* (Smith, 1855, 249, analysis). *Azurite:* crystals up to 1/2 inch across (Smith, 1855, 250, analysis; Genth, 1875, 168). *Calamine:* white, yellowish or bluish; silky tufts or botryoidal masses (Dana, 1854, 489; Smith, 1855, 250; Genth, 1875, 106; Eyerman, 1911, 9, analysis. The wavellite reported by Eyerman, 1889, 40, was undoubtedly calamine). *Pyromorphite:* light green to dark green prismatic crystals, often cavernous; columnar, botryoidal, plumose or granular masses (Dana, 1850, 654; Blake, 1852, 116; Smith, 1855, 247; Genth, 1875, 139; 1876, 227, analysis; Eyerman, 1911, 19, analysis). *Mimetite:* colorless, yellow, or greenish-yellow crystals similar to pyromorphite, but more commonly modified by pyramids; sometimes occurs as a tabular crystal or cap on pyromorphite (Smith, 1855, 127; 248; Genth, 1875, 140). *Vanadinite:* (Dana, 1854, 489; Smith, 1855, 127). *Pseudomalachite:* (Dana; 1854, 489). *Descloizite:* dark colored crystalline crusts of minute purple crystals (Smith, 1855, 246, rough analysis; Genth, 1875, 140). *Erythrite:* rose-pink coatings (Lewis, 1885, 120). *Anglesite:* colorless, occasionally black, green, or yellow, due to inclusions of galena, malachite, or limonite; pyramidal, tabular or prismatic crystals up to a half pound in weight and measuring 5 1/2 × 1 1/2 inches (Dana, 1850, 654; Blake, 1852, 116; Dana, 1854, 419; 1868, 623; Smith, 1855, 244; Lang, 1859; Schrauf, 1871, fig. 52; Genth, 1875, 147). *Wulfenite:* bright yellow or red,

[140] The locality is commonly known as "Phoenixville." It is first mentioned by Dana, 1850, 654, as "Near Kinsey's Mill." The mines are described in detail by Rogers, 1858, II, 698, with a map.

tabular or pyramidal crystals (Blake, 1851, 247; 1852, 116; 105; Wetherill, 1852, 55; 119; Smith, 1855, 245, analysis; Koch, 1882, 402). *Stolzite:* yellowish-gray pyramidal crystals on quartz, with pyromorphite and wulfenite, sometimes enclosed within the latter (Rand, 1867, 403). *Mendipite?* (Dana, 1854, 489). *Chalcanthite?* (Eyerman, 1911, 20).

JUG HOLLOW MINE.[141] On the road to Williams Corner, about 1 1/2 miles west of Valley Forge. (Norristown 4752). Abandoned and practically inaccessible. Triassic shales; hydrothermal veins.

Amethyst: (Benge and Wherry, XV, 1908, 109). *Barite:* (Genth, 1875, 146). *Hematite:* (Benge and Wherry, l. c.). *Chalcopyrite.* (Genth, 1875, 14). *Sphalerite:* pale yellow to greenish-yellow crystals up to an inch in diameter (Genth, 1875, 14).

SOUTH COVENTRY TOWNSHIP

COVENTRYVILLE. Graphite mine on French Creek, 1/2 mile south of Coventryville. Pickering gneiss. (Phoenixville 1976).

Graphite: (Benge and Wherry, XV, 1908, 6). *Halotrichite:* weathering product on gneiss (Genth, 1875, 150).

Small limestone quarry on the south side of French Creek, opposite the graphite mine (Phoenixville 1979). Franklin limestone. Abandoned.

Graphite: (Dana, 1850, 654). *Augite:* (Dana, l. c.). *Zircon:* (Dana, l. c.). *Titanite:* (Dana, l. c.).

PUGHTOWN. Exposures about 1/4 mile southwest of Pughtown, near the junction of Beaver and French Creeks. Pickering gneiss.

Graphite: (Rogers, 1850, II, 709). *Hematite:* (Rogers, l. c.). *Wad:* (Rogers, l. c.).

NORTH OF PUGHTOWN.

Graphite: (Dana, 1850, 654). *Magnetite:* crystals (Dana, l. c.). *Zircon:* (Dana, l. c.). *Titanite:* (Dana, l. c.).

SOUTH OF PUGHTOWN.

Allanite: (Genth, 1875, 79). *Zircon:* (Benge and Wherry, XV, 1908, 7).

THORNBURY TOWNSHIP

DILWORTHTOWN. Abraham Darlington's quarry, about 1 mile northwest of Dilworthtown. Shenandoah limestone.

Calcite: (Benge and Wherry, XV, 1908, 54).

BRINTON'S FARM. Three-eighths of a mile southeast of Darlington's Corners. (West Chester 6121). Wissahickon gneiss; pegmatite in a road-cut south of the house.

Muscovite: plates measuring a foot square, containing acicular crystals of tourmaline (Dana, 1868, 778). *Tourmaline:* in muscovite: (Dana, l. c.). *Ilmenite:* in the fields (Genth, 1875, 36). *Rutile:* in the fields (Dana, 1868, 778).

TREDYFFRIN TOWNSHIP

DIAMOND ROCK. Exposures in woods on the south slope of North Valley Hill, just west of the road going south to Paoli, 2 miles southwest of Valley Forge. Chickies quartzite.

Quartz: crystals (Genth, 1875, 57; Benge and Wherry, XV, 1908, 27).

HOWELLVILLE. Quarry south of Howellville Sta., P. & R. Ry. Shenandoah limestone.

Calcite: prismatic crystals 2 inches in length. Also occurs in the quarry at Gallagerville. *Fluorite:* purple masses (Jefferis, 1880, 243).

CEDAR HOLLOW. Hill east of Cedar Hollow Station.

Limonite pseudo. *pyrite:* cubes (Eyerman, 1889, 5; McKinstry). Crystals occur in the soil on nearly every farm in the vicinity (Dana, 1868, 778; Jefferis, 1892, 191).

UPPER UWCHLAN TOWNSHIP

UWCHLAN. Exposures 1/4 mile north of Eagle Tavern, Uwchlan (or Windsor; Byers Sta.). Pickering gneiss. (Benge and Wherry, XV, 1908, 7).

Quartz: blue (Dana, 1868, 778). *Graphite:* (Dana, l. c.).

BYERS. Graphite mines near Byers Sta., P. & R. Ry. Pickering gneiss.

[141] Or Napoleon mine.

Graphite: (Benge and Wherry, XV, 1908, 7). *Pyrrhotite:* (Benge and Wherry, l. c.). *Aragonite:* (Benge and Wherry, l. c.).

Valley Township

Coatesville. Exposures and quarries on Lancaster Turnpike, northwest of Coatesville. Chickies quartzite; pegmatite.

Quartz: amethyst, and smoky (Benge and Wherry, XV, 1908, 26). *Tourmaline:* (Benge and Wherry, l. c.). *Hematite:* titaniferous (Benge and Wherry, l. c.). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.)

Southwest of Coatesville. Exposures and washouts along the Valley Road, southwest of Coatesville.

Rutile: (Benge and Wherry, XV, 1908, 26).

Hoofman's Farm. One mile northeast of Pomeroy.

Limonite pseudo. *pyrite:* (Rand, 1894, 458).

Wallace Township

Springton. Roadside exposures at Springton Sta., P. R. R. Pickering gneiss.

Zircon: crystals (Benge and Wherry, XV, 1908, 7; Wherry, 1908, 72).

Excavations north of Springton Station.

Hematite: (Benge and Wherry, XV, 1908, 7). *Magnetite:* (Benge and Wherry, l. c.).

One and a half miles west of Springton.

Zircon: (Benge and Wherry, XV, 1908, 7). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.).

Lyndell. Fields 1 mile west of Lyndell Station, P. R. R. Octoraro schist.

Pyrite: crystals partially altered to limonite (Benge and Wherry, XV, 1908, 7).

Warwick Township

Hopewell Mines. One mile northwest of Warwick Sta. P. & R. Ry. (Honeybrook 3799 and 3877). Idle. Pickering gneiss; Shenandoah? limestone; Triassic shales; intrusive diabase; tactite; hydrothermal deposits replacing the limestone.

Orthoclase: (Benge and Wherry, XV, 1908, 6). *Hornblende; byssolite:* (Benge and Wherry, l. c.). *Andradite:* crystals (Benge and Wherry, l. c.). *Epidote:* crystals (Benge and Wherry, l. c.). *Pyrite:* (Jefferis, 1892, 192). *Hematite:* micaceous (Benge and Wherry, l. c.). *Magnetite:* octahedra (Rogers, 1858, II, 707). *Quartz:* crystals; sometimes pseudomorphous (Jefferis, l. c.). *Chalcedony:* (Genth, 1875, 59).

Steele's Mine. On the side of Steele's Hill, about 1/2 mile north of Warwick Sta. (Honeybrook 3892). Overgrown.

Coccolite: (Dana, 1850, 653). *Andradite:* (Smith, 1855, 188). *Magnetite:* octahedra (Dana, l. c.). *Hematite:* micaceous (Dana, l. c.).

Warwick Mines. Warwick Mines, 1/2 mile southeast of Warwick Sta., just southeast of St. Mary's. Triassic conglomerate and diabase; tactite; hydrothermal replacement deposits.

Orthoclase: (Genth, 1875, 94; Benge and Wherry, XV, 1908, 6). *Hornblende; actinolite, byssolite:* (Dana, 1868, 778; Genth, 1875, 68). *Andradite; melanite:* brilliant brownish-black to jet black dodecahedra measuring an inch (Dana, 1868, 778; Genth, 1875, 75). *Epidote:* crystals (Rogers, 1858, II, 708). *Serpentine:* (Rogers, 1858, II, 708). *Calcite:* (Benge and Wherry, l. c.). *Magnetite:* dodecahedra (Dana, 1868, 778). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Bornite:* (Genth, 1875, 13).

French Creek Mines.[142] About 1/8th mile east of St. Peter's Sta., P. & R. Ry. (Knauertown). The two old shafts were known as the Keim or lower mine, and the Elizabeth, or upper mine, from their respective positions on the side of the hill (Phoenixville 1737 and 1761). The Crossley pits were about a hundred yards to the east. A large slope was driven in 1918. Pickering? gneiss; Shenandoah? limestone; Triassic red shales; intrusive diabase; hydrothermal deposits replacing the limestone; tactite.

Minerals of the gneiss: *Orthoclase:* reddish-white, flesh-red, or light-green; columnar,

[142] Asbeferrite was reported by Goldsmith, 1893, 174, but the material was undoubtedly byssolite. Eyerman (1889, 16) listed pyrallolite.

radiating aggregates of slender crystals (Genth, 1885, 43, analysis; Eyerman, 1889, 58; Jefferis, 1892, 192). *Augite:* (Eyerman, 1889, 58). *Diallage; salite:* (Eyerman, 1889, 16). *Wernerite:* colorless, white, and grayish-white, columnar striated crystals (Genth, 1890, 162, analyses). *Chalcodite:* in cavities in feldspar (Smith, 1885, 412, analysis, "glauconite;" probably the thuringite of Benge and Wherry, XV, 1908, 6). *Graphite:* (Benge and Wherry, l. c.). *Molybdenite?* (Dana, 1854, 489).

Limestone; contact metamorphs: *Calcite:* colorless, white, dark-yellow, and deep green enclosing byssolite (Rogers, 1858, II, 707; Genth, 1875, 153; Eyerman, 1889, 43). *Hornblende; actinolite; byssolite:* light green to greenish-black; radiating; needle-like crystals, or masses of needles (resembling mountain-cork), sometimes disseminated in calcite, and coloring it a deep green (Dana, 1868, 778; 1850, 654; Eyerman, 1889, 16; Benge and Wherry, XV, 1906, 6). *Andradite:* brilliant dodecahedra up to $2^1/_2$ inches in diameter (Dana, 1850, 654; Genth, 1875, 75; Eyerman, 1911, 6, analysis). *Tourmaline:* black, radiating crystals. *Serpentine; metaxite:* (Dana, 1850, 654).

Hydrothermal deposits; primary.[143] *Calcite:* colorless crystals up to $2 \times 1/_2$ inches showing the forms *m* $(10\bar{1}0)$, *v* $(21\bar{3}1)$, and *e* $(01\bar{1}2)$ (striated), Keim mine (Gordon, Am. Min., 3, 164, 1918). *Apophyllite:* colorless, white, light pink; tabular to pyramidal crystals, sometimes in quite large slabs; lamellar masses (Smith, 1885, 413, analysis; Eyerman, 1889, 29, 34; 1889, 57; 1904, 43; 1911, 11; analyses). *Ankerite:* (Benge and Wherry, l. c.). *Siderite:* (Dana, 1892, 1068). *Rhodochrosite:* (Dana, 1892, 1068). *Pyrite:* brilliant octahedra measuring 45 mm.; cubes measuring 28 mm.; rarely in elongated octahedra, or spinel twins in calcite; cobaltiferous (Dana, 1850, 654; Genth, 1875, 20; Eyerman, 1889, 57; 1889, 34; Penfield, 1889, 209; Genth, 1890, 114, analysis; Nicol, 1904, 93; Wherry, 1920, 116). *Pyrrhotite:* massive, rarely in pseudohexagonal crystals, of tabular habit, 1 cm. in diameter. *Chalcopyrite:* single and grouped sphenoids, single crystals measuring 30 mm., often tarnished (Dana, 1850, 654; Genth, 1875, 21; Penfield, 1890, 207). *Bornite:* (Dana, 1868, 778). *Sphalerite; marmatite:* black dodecahedra measuring an inch, in calcite or byssolite. *Hematite:* (Dana, 1850, 654). *Magnetite:* foliated masses, or bright octahedral crystals (Dana, 1854, 489; Genth, 1875, 39; Eyerman, 1889, 59).

Hydrothermal deposits; hydrometamorphs and weathering products: *Aragonite:* flos ferri; fibrous, stalactitic (Dana, 1850, 654; Genth, 1875, 162). *Gypsum:* small crystals (Benge and Wherry, l. c.). *Malachite:* (Dana, 1850, 654). *Chrysocolla:* (Genth, 1875, 105). *Erythrite:* coatings on calcite (Eyerman, 1889, 40).

Diabase; hydrothermal metamorphs: *Apophyllite:* druses of crystals (Smith, l. c.; Eyerman, l. c.). *Stilbite:* prismatic crystals (Eyerman, 1889, 32; 57; analysis). *Heulandite:* (Oldach; Am. Min., 2, 83, 1917).

TRAP QUARRY. $1/_4$ mile south of St. Peter's Sta. Triassic diabase; hydrothermal metamorphic veins. (Phoenixville 1767).

Apophyllite: (Benge and Wherry, XV, 1908, 6). *Stilbite:* (Benge and Wherry, l. c.).

WEST BRADFORD TOWNSHIP[144]

YOUNG'S FARM. Exposure on Young's farm, on the road to Romansville, 2 miles west of Harmony Hill. (West Chester 1298). Octoraro schist.

Fuchsite: (Benge and Wherry, XV, 1908, 27; Wherry, XIV, 1908, 172; 1915, 465, partial analysis).

POORHOUSE QUARRY. About $1/_2$ mile north of Glenhall Sta., P. & R. Ry. (West Chester 1587). Shenandoah limestone.

Limestone; hydrothermal metamorphs: *Quartz:* crystals $4 \times 1^1/_2$ inches (Carpenter, 1828, 7). *Calcite:* scalenohedra (Dana, 1850, 654). *Dolomite:* crystals (Dana, l. c.). *Microcline; chesterlite:* white to flesh colored crystals (Dana, 1850, 654; Breithaupt, 1858, 1; Smith and Brush, 1853, 42; Lea, 1866, 113; Descloizeaux, 1876, 433, 461, 463, 465, analysis). *Tremolite:* (Benge and Wherry, XV, 1908, 27); mountain leather (Rand, 1867, 405). *Muscovite; damourite:* "talc:" minute tuft-like aggregates (Dana, 1850, 654; Smith and Brush, 1853, 47; Genth, 1875, 124). *Phlogopite:* (Rogers, 1858, I, 230). *Zoisite?* (Dana, 1850, 654). *Chlorite:* (Benge and

[143] The calcite, apophyllite, and other carbonates listed were introduced at a late stage of the mineralization.

[144] Carpenter, 1828, 7, listed epidote crystals from "Smith and McMullin's Farms;" Dana, 1850, 654: serpentine and chromite from Marshall's Mill.

Wherry, l. c.). *Rutile:* brilliant ruby-red, rarely transparent, striated and terminated prismatic or acicular crystals up to an inch in length (Carpenter, 1828, 7; Rand, 1867, 405). *Pyrite:* cubes and cubo-octahedra (Carpenter, 1828, 7).

MARSHALLTON. Exposures on the road from Copesville to Embreeville, about 1/2 mile northwest of Marshallton. Wissahickon gneiss and pegmatite.

Almandite: (Benge and Wherry, XV, 1908, 27). *Cyanite:* also occurs on the Strasburg road, west of Marshallton (Benge and Wherry, l. c.; Dana, 1850, 654, also lists scapolite, staurolite, and rutile from this vicinity; Carpenter, and Spackman, 1826, 220, reported andalusite).

WEST GOSHEN TOWNSHIP

TAYLOR'S QUARRY. On Taylor's Run, just northwest of West Chester; and the exposures in the vicinity along the serpentine ridge. Meta-peridotite.

Peridotite; primary: *Chromite:* octahedra (Finch, 1828, 18; Eyerman, 1889, 18).

Peridotite; hydrothermal metamorphs: *Serpentine:* *"cerolite," retinalite, chrysotile:* (Carpenter and Spackman, 1826, 219; Genth, 1875, 62; Benge and Wherry, XV, 1908, 44). *Amphibole asbestus* (Lea, 1818, 478). *Epidote:* crystals in serpentine (Dana, 1850, 654; McKinstry). *Talc:* (Finch, 1828, 17). *Magnetite:* octahedra (Carpenter and Spackman, 1826, 219).

Meta-peridotite; weathering products: *Deweylite:* (Benge and Wherry, l. c.). *Calcite:* veins (Finch, 1828, 18). *Aragonite:* stellated crystals, columnar or fibrous (Rand, 1867, 404; Carpenter and Spackman, 1826, 219; called "acicular carbonate of magnesia" by the early writers). *Magnesite:* crusts (Finch, 1828, 18).

North of Taylor's House, in the road. Wissahickon gneiss.

Almandite: crystals (Jefferis, 1892, 187). *Staurolite:* crystals (Eyerman, 1829, 28).

MARSHALL'S QUARRY. One-half mile west of Fernhill Sta. Abandoned. Meta-peridotite.

Peridotite; hydrothermal metamorphs: *Serpentine; retinalite; marmolite:* (Jefferis, 1892, 187; Benge and Wherry, XV, 1908, 44). *Talc:* white or gray, indurated, occurs above the quarry on the hillside (Carpenter and Spackman, 1826, 219). *Dolomite:* (Jefferis, l. c.).

Meta-peridotite; weathering products: *Aragonite:* small radiated crystals (Jefferis, l. c.). *Quartz:* drusy; chalcedony; jasper: yellow, red, and brown, occur on the serpentine ridge, east of the quarry (Carpenter and Spackman, 1826, 219).

GENERAL MCCALL'S QUARRY. A few hundred yards east of Marshall's quarry. Meta-peridotite.

Chrysotile: (Jefferis, 1892, 187).

WEST CHESTER.[145] In a field opposite Painter's ice house, on East Gay Street, Baltimore gneiss. Inaccessible.

Quartz pseudo. *calcite:* (Benge and Wherry, XV, 1908, 44).

Site of the former West Chester Water Works, northeast of West Chester County Hospital. Old quarry. "Bath Springs" or "Bath Woods." Meta-gabbro. (West Chester 2612).

Zoisite: grayish-brown, radiating columnar masses (Carpenter, 1828, 9; Eyerman, 1911, 8; analysis; Genth, 1875, 81; Finch, 1828, 17). *Zircon:* (Carpenter and Spackman, 1826, 219).

WEST MARLBORO TOWNSHIP[146]

DOE RUN QUARRIES. Bernard's Quarry, 1/4 mile south of Doe Run Village (Coatesville 6126); McNeal's quarry, 1/4 mile west of Doe Run Village (Coatesville 3787). Other quarries lie north of Springdell. Shenandoah limestone.

Limestone; hydrothermal metamorphs: *Quartz:* limpid crystals; sometimes pseudomorphous (Carpenter and Spackman, 1826, 223). *Tremolite:* white, radiating masses (Carpenter and Spackman, l. c.). *Wernerite:* prisms (Carpenter and Spackman, l. c.). *Vesuvianite:* reddish-brown prisms (Carpenter and Spackman, l. c.). *Tourmaline:* brown (Carpenter and Spackman, l. c.). *Apatite:* yellowish-green crystals (Carpenter, 1828, 6). *Pyrite:* cubes (Carpenter, and Spackman, l. c.). *Rutile:* striated prisms (Carpenter, l. c.).

Limestone; hydrometamorphs: *Calcite:* straw-yellow scalenohedra (Carpenter, 1828, 6).

[145] Lea (1866, 112; 1869, 120) listed delawarite, and a black and bluish feldspar, with black acicular inclusions from "near West Chester."

[146] Townsend (1839, 7) lists chromite from "Joel Swayne's farm."

Siderite: rhombs (Carpenter, l. c.). *Nitrocalcite:* acicular crystals were found in a cave in McNeal's quarry (Carpenter and Spackman, 1826, 223).

BAILEY'S QUARRY. Three-eighths of a mile west of Upland. Shenandoah limestone.

Limestone: hydrothermal metamorphs: *Pyroxene; diopside, malacolite:* radiating, apple-green (Genth, 1876, 219, analysis; Eyerman, 1911, 4). *Mussite:* grayish white columnar masses (Genth, 1875, 65). *Tremolite:* terminated prismatic crystals; white, radiating masses (Carpenter, 1828, 6). *Wernerite:* (Dana, 1868, 777). *Epidote:* yellowish-green crystals (Carpenter, 1828, 6). *Margarodite:* (Benge and Wherry, XV, 1908, 54). *Rutile:* striated prisms (Carpenter, l. c.). *Pyrite:* crystals (Carpenter, l. c.).

Exposures and fields nearby. Wissahickon gneiss.

Cyanite: (Dana, 1868, 777).

WEST NANTMEAL TOWNSHIP

Graphite: in blue quartz (Townsend, 1839, 8).

WEST NOTTINGHAM TOWNSHIP[147]

NOTTINGHAM. Moro Phillip's chrome mine, one mile S. S. E. of Nottingham. (Havre de Grace 9351). Meta-peridotite.

Amphibole asbestus: (Genth, 1875, 68). *Chromite:* black, massive. *Zaratite:* weathering product occurring on chromite (Genth, 1875, 166).

SCOTT'S CHROME MINE. One and a half miles S. W. of Nottingham (Havre de Grace 9228). Meta-peridotite.

Serpentine; marmolite: thin foliated (Dana, 1850, 654). *Penninite; kammererite:* pink, scaly-fibrous (Dana, 1868, 778; Genth, 1875, 131). *Talc:* greenish-white foliated masses (Dana, l. c.). *Magnesite:* massive, compact, white (Genth, 1875, 157). *Chromite:* black, massive.

BLACK RUN PLACERS. 2 miles southwest of Nottingham.

Chalcedony: (Genth, 1875, 59). *Rutile:* (Genth, 1875, 44). *Brookite:* (Genth, 1875, 45). *Chromite:* (Genth, 1875, 42). *Zircon:* (Genth, 1875, 77).

SYLMAR. Exposures one half mile north of Sylmar. Meta-peridotite.

Tremolite: large crystals in talc.

SPAR QUARRIES. One and a half miles W. N. W., one and a half, and one and three-quarters miles N. W. of Sylmar, south of Black Run (Havre de Grace 9252, 9264, 9246, 9254, 9266, 9249, 9274). Desilicated granitic pegmatites in meta-peridotite.

Peridotite: hydrothermal metamorphs: *Serpentine:* (Benge and Wherry, XV, 1908, 70; Wherry, 1918, 47). *Talc:* green foliated masses. *Actinolite:* green, in talc. *Amphibole asbestus:* (Benge and Wherry, XV, 1908, 70). *Zoisite:* (Wherry, 1918, 47).

Pegmatite; primary: *Albite:* white, yellow, and greenish, translucent masses (Dana, 1850, 654; Benge and Wherry, XV, 1908, 70, "leelite"). *Tourmaline:* black crystals. *Beryl:* opaque yellow crystals. *Muscovite:* white, micaceous masses in albite. *Apatite:* (Wherry, 1918, 47). *Molybdenite:* disseminations in albite.

Pegmatite; weathering products: *Colerainite:* white, rosettes on albite; massive. *Vermiculite; roseite:* weathering product, on albite.

DUNLAP'S QUARRY. 1 mile N. W. of Sylmar. (Havre de Grace 9282). Meta-peridotite.

Anthophyllite: fibrous masses. *Amphibole asbestus:* ligniform masses.

FREMONT. One mile N. E. of Fremont.

Goethite: geodes, abundant.

Exposures two miles S. W. of Fremont. Meta-peridotite and plumasite.

Albite: (Genth, 1875, 32; Benge and Wherry, XV, 1908, 70, "leelite"). *Corundum:* crystals in albite (Genth, 1875, 32).

GOAT HILL. Magnesia quarries east of Goat Hill, one and a half miles S. E. of Lee's Mill (Havre de Grace 9178). Meta-peridotite, and plumasite.

Plumasite: *Albite:* greenish-gray, granular (Dana, 1850, 654, "leelite;" Genth, 1875, 91).

Meta-peridotite: *Serpentine; marmolite:* thin foliated (Dana, 1850, 654). *Sepiolite;*

[147] Thomas Haines found dark blue corundum in albite in the township, the exact locality being unknown (Pennypacker, 1897, 115). Enstatite (Eyerman, 1889, 15), hematite and staurolite have been reported (Carpenter, 1828, 9; Jefferis, 1892, 189).

meerschaum: compact, smooth, earthy (Genth, 1875, 112). *Magnesite:* white, massive, compact (Genth, 1875, 158, analysis). *Deweylite:* brown, massive, weathering product (Dana, 1868, 778; Genth, 1875, 117).

Exposures near the Maryland line.

Siderite: crystals on goethite.

West Pikeland Township

Chester Springs.[148] Orner Mine, about 1 mile N. E. of Chester Springs Sta., P. & R. Ry. Pickering gneiss.

Graphite: (Benge and Wherry, XV, 1908, 7). *Hematite:* (Benge and Wherry, l. c.).

Iron pits at Chester Springs: Steitler's ore bank, 1/2 mile northwest of the station; and Lewis' ore bank, 1 1/2 miles northeast on the road to Kimberton. Long abandoned and filled with water. Pickering gneiss and pegmatite; residual deposits of goethite.

Quartz: blue (Seybert, 1808, 156). *Allanite:* (Lea, 1882, 60). *Zircon:* (Lea, 1868, 778; Lea, l. c.). *Muscovite:* white (Rogers, 1858, I, 89). *Graphite:* (Rogers, 1858, I, 87). *Pyrite:* (Rogers, l. c.). *Hematite:* specular at Lewis' bank. *Goethite:* radiating, fibrous; geodes (Rogers, 1858, I, 89; Genth, 1875, 48). *Lepidocrocite:* crystalline coatings on goethite (Genth, 1875, 48). *Limonite:* (Rogers, 1858, I, 89). *Turgite:* on goethite (Genth, 1875, 47). *Wad:* (Rogers, 1858, I, 89). *Gibbsite:* (Dana, 1868, 778). *Allophane:* silvery-white, mammillary coatings (Jefferis, 1892, 192).

West Sadsbury Township

Cuts and improvements on the P. R. R. between Christiana and Atglen. Chickies quartzite, Octoraro schist; pegmatite.

Bismuth? (Benge and Wherry, XV, 1908, 26; a specimen in the Rand Collection, Bryn Mawr). *Rutile:* (Benge and Wherry, l. c.). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.). *Tourmaline:* near Atglen (Benge and Wherry, l. c.).

Westtown Township

Brinton's Quarries.[149] About 3 miles south of West Chester, on the Birmingham Road (continuation of South New Street, West Chester), southeast of its crossing with the Street Road (West Chester 5322). Idle. Meta-peridotite and desilicated granitic pegmatite.

Peridotite; primary: *Bronzite:* (McKinstry, 1916, 60). *Chromite:* nodules, crystals (Benge and Wherry, XV, 1908, 54).

Peridotite; hydrothermal metamorphs: *Actinolite:* (Dana, 1868, 778). *Amphibole asbestus:* (Dana, 1868, 778). *Serpentine:* (Lea, 1818, 478). *Clinochlore; ripidolite:* crystals in talc, 50 yards east of the jefferisite vein; (Blake, 1851, 238; 339; 1852, 222; analyses by Blake, l. c.; Neminarz, 1874, 176; Clarke and Schneider, 1890, 406; Schlaepfer, 1891, 8; crystallography by Blake, l. c.; Dana, 1853, 436; 1854, 293; Cooke, 1867, 205; Descloizeaux, 1868, 637; Bauer, 1869, 367; Tschermak, 1890, 99; 1891, I, 221–229; Klein, 1894, 770). *Talc:* green, foliated (Dana, 1868, 778). *Magnetite:* veins in serpentine (Blake, 1851, 238). *Ilmenite:* lumps in serpentine (Dana, 1868, 778).

Meta-peridotite; weathering products: *Quartz:* drusy (Genth, 1875, 57; amethystine, McKinstry, 1920, 37). *Aragonite:* fibrous, radiating (Smith and Brush, 1883, 215; Genth, 1875, 162). *Deweylite:* yellow (Eyerman, 1889, 36). *Sepiolite:* (Benge and Wherry, XV, 1908, 54). *Magnesite:* yellowish-white, earthy, compact (Blake, 1851, 339; Genth, 1875, 157). *Limonite:* (McKinstry, 1916, 60).

Desilicated granitic pegmatite; primary: *Amethyst?* (Jefferis, 1892, 189). *Oligoclase:* colorless, striated (Genth, 1875, 90; 1876, 223, analysis). *Beryl:* green crystals (Genth, 1875, 71). *Tourmaline:* (Jefferis, 1892, 189). *Muscovite:* (Dana, 1868, 778). *Apatite:* (McKinstry, 1916, 59).

Pegmatite; weathering products: *Jefferisite:* brownish crystals and masses representing an altered biotite (Dana, 1854, 489; Brush, 1861, 369; 1866, 248; Bauer, 1869, 368; Cooke, 1874, 44;

[148] Formerly Yellow Springs.

[149] Commonly known as "West Chester," "Westtown," "Birmingham quarries" or "Ingram's quarry." For a general description of the quarries, see McKinstry, 1916, 57). Boyé (1841, 190) gives an analysis by Nuttall of a white feldspar, enclosing corundum, from "three miles south of West Chester."

Clarke and Schneider, 1890, 452; analyses). *Colerainite:* white or faintly pinkish, rosettes of trigonal scales; also massive.

WILLISTOWN TOWNSHIP

WILLISTOWN. *Actinolite:* (Dana, 1850, 655). *Amphibole asbestus:* (Dana, 1868, 778). *Chromite:* (Dana, 1850, 655). *Magnetite:* (Dana, 1850, 655); lodestone occurs 4 1/2 miles northeast of West Chester (Jefferis, 1892, 187). *Chalcedony:* brown, botryoidal (Genth, 1875, 59).

WEST CHESTER TURNPIKE.

Hyalite: (Eyerman, 1889, 14).

PAOLI. One-half mile south of Paoli.

Magnesite: in a chlorite schist (Eyerman, 1889, 43).

WEST WHITELAND TOWNSHIP[150]

OAKLAND. Dr. J. P. Thomas' quarry, 1/2 mile N. W. of Oakland Sta. Shenandoah limestone.

Calcite: (Benge and Wherry, XV, 1908, 26).

South of the quarry.

Goethite: geodes (Genth, 1875, 50).

CLARION COUNTY

MECHANICSVILLE. Steward's Coal Bank; Limestone Township.

Calcite: in geodes in slaty shales overlying the Kittaning Lower Coal Bed. (Eyerman, 1889, 44; H. M. Chance, Geology of Clarion County, Sec. Geol. Surv. Penna. Rep. V2, 1880, 140). *Siderite:* crystals in geodes (Eyerman, l. c.; Chance, l. c.).

CLEARFIELD COUNTY

CLEARFIELD CREEK.

Cerussite? (Eyerman, 1911, 22).

COLUMBIA COUNTY

ESPY MINE.[151] Half way between Espy and Lime Ridge. Lower Helderberg Limestone.

Calcite: (Cleaveland, 1816, 531). *Galena:* (Genth, 1875, 11). *Sphalerite:* (Cleaveland, l. c.). *Magnetite:* (Dana, 1850, 655).

CUMBERLAND COUNTY[152]

PINE GROVE.

Fluorite: violet, in Thomas' quarry (Genth, 1876, 210).

KIMMEL'S FARM. Two miles north of New Kingston, on a small run S. W. of Conodoquinet Creek, Silver Spring Township (New Bloomfield 8996). Cambro-ordovician (?) limestone.

Quartz: doubly terminated crystals; colorless, yellow and smoky; of prismatic or pyramidal habit, often in groups of crystals in parallel position. Individual crystals measure 2.5 cm. (Holden, 1917, 81).

CARLISLE. One and a half miles N. W. of Carlisle.

Quartz: smoky, colorless or amethystine doubly-terminated crystals in the soil (Groth, 1896, 85).

MOORE'S MILL.[153] Phosphorus ore mine 1 1/4 miles S. E. of Moore's Mill (about 4 miles west of Mount Holly Springs). The mine has been abandoned. The pit lies at the foot of South

[150] (Carpenter 1828, 9), listed calcite from Robert's lime quarry, 4 miles north of West Chester.

[151] Undoubtedly the Webb mine of Cleveland.

[152] Genth, 1875, 112, listed talc from "10 miles south of Carlisle; and albite in minute crystals from "Cumberand Co."

[153] For a description of the deposits see Stose, 1907, 474. The locality was called "Cly, York County" by Ungemach; this was the site of the factory of the phosphorus company. According to Stose wavellite also occurs at Upper Mill, 1 mile south of Mount Holly Springs. The analyses of the iron ores of Mountain Creek Valley indicate that wavellite occurs at most of the old iron banks.

Mountain, about $^3/_8$ of a mile south of Yellow Breeches Creek. Cambrian and Ordovician sedimentary rocks; residual deposits of clay, etc.

Wavellite: massive, nodular; radiating masses; prismatic crystals 1 mm. in diameter (Eyerman, 1911, 20; Ungemach, 1912, 536), *Beraunite; eleonorite:* druses of brilliant reddish-brown crystals. *Cacoxenite:* golden-yellow or greenish-yellow aggregates of radiating acicular crystals. *Strengite:* white waxy concretions of radiating structure, with beraunite and cacoxenite.

DAUPHIN COUNTY

HUMMELSTOWN.[154] Magnetite mines 2 miles south of Hummelstown, on the east side of Waltonville Brook. Triassic sandstones, and hydrothermal deposits.

Magnetite: massive (Spencer, 1908, 29). *Hematite:* specular (Genth, 1875, 34). *Pyrite:* (Spencer, l. c.). *Grossularite:* (Dana, 1850, 655).

DELAWARE COUNTY

ASTON TOWNSHIP

MORGAN.[155] Quarry just south of Morgan Sta., P. B. & W. R. R.; west of Chester Creek (Chester 5484). Abandoned. Wissahickon gneiss and pegmatite.

Microcline: reddish (Benge and Wherry, XIV, 1907, 5). *Hornblende:* (Benge and Wherry, l. c.). *Muscovite:* green (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, XV, 1908, 109). *Chabazite:* (Benge and Wherry, l. c.). *Leidyite:* (Benge and Wherry, l. c.). *Hematite:* (Benge and Wherry, XIV, 1907, 5). *Magnetite:* (Benge and Wherry, l. c.). *Ilmenite:* (Benge and Wherry, l. c.). *Marcasite:* casts of large crystals (Benge and Wherry, XV, 1908, 109). *Zircon; cyrtolite:* small crystals (Harold Tomlinson, Mineral Collector, V, 1899, 177; Wherry, 1908, 72). *Monazite:* small crystals (Hamilton, 1899, 377).

SMITH'S FARM.[156] $^1/_4$ mile south of Morgan Sta. Abandoned corundum pit, and exposures along creek bed. (Chester 5454). Wissahickon gneiss; meta-peridotite; corundum pegmatite (plumasite).

Corundum: large brown crystals, often with a bronzy luster, usually completely sheathed by a coating of scaly margarite (Dana, 1850, 655; Genth, 1875, 32; 1882, 388; Hall, 1885, 75). *Margarite:* pearly white, micaceous; occurring as an alteration product on corundum (Silliman, Jr., 1849, 379–380, analyses; Dana, 1850, 362, analysis; Genth, 1875, 137; 1882, 388). *Sillimanite:* small fibres in quartz (Genth, 1875, 99).

MENDENHALL'S FARM. West of Morgan Sta., and north of the Dutton's Mill Road. Many of the minerals were found in exposures along the road. Wissahickon gneiss and pegmatite.

Amethyst: clusters and isolated crystals. An old and prolific locality was a vein which ran across the Dutton's Mill road. (Rand, 1867, 274; Genth, 1875, 57; Dana, 1850, 655; Cardeza, 1892, 198). *Rutile:* minute ruby-colored crystals on modified quartz crystals (Cardeza, 1892, 198). *Ilmenite:* black tabular crystals measuring $10 \times 4 \times 2$ cm. (Rand, 1867, 274; Genth, 1875, 36). *Sillimanite:* (Dana, 1850, 655; Rand, 1867, 274). *Staurolite:* small crystals in quartz (Rand, l. c.). *Muscovite:* crystals (Rand, l. c.); muscovite crystals also occur north of Dutton's Mills, on the east side of Chester Creek. *Tourmaline:* crystals (Dana, 1850, 655).

JUDGE TYSON'S FARM. $^1/_2$ mile west of Morgan Sta., and west of the Dutton's Mill—Village Green cross-roads. Wissahickon gneiss and pegmatite.

Tourmaline: acicular crystals (Cardeza, 1892, 198).

VILLAGE GREEN. A short distance south of Village Green on the Marcus Hook Road. Wissahickon gneiss and pegmatite.

Tourmaline: crystals in milky quartz (Hall, 1885, 75).

Asbestus Pits, $^1/_2$ mile southwest of Village Green. Meta-pyroxenite, meta-peridotite.

Amphibole asbestus: (Dana, 1850, 655; Cardeza, 1892, 198). *Clinochlore:* (Thomas Harvey, priv. comm.). *Talc:* (Thomas Harvey); talc also occurs on the Marcus Hook road, $^1/_2$ mile north of Village Green (Hall, 1885, 75).

[154] Dana, 1850, 655, lists smoky quartz and feldspar from "near Hummelstown."

[155] The localities in the vicinity of Morgan Station were formerly known as "Dutton's Mill," situated west of Chester Creek in Middletown Township.

[156] Formerly Isaac Morgan's farm. This was the "Village Green" locality of the early writers.

HALBERSETT'S FARM, 1/2 mile north of Village Green, on the Marcus Hook Road. Meta-pyroxenite.

Enstatite: (Cardeza, 1892, 198). *Talc:* (Hall, 1885, 75). *Quartz:* drusy (Cardeza, l. c.).

ROCKDALE. Exposures at Rockdale, 1/2 mile south of Glen Riddle Sta., P. B. & W. R. R. Meta-pyroxenite; Wissahickon gneiss, and pegmatite.

Actinolite: green crystalline masses (Genth, 1875, 67). *Hornblende:* greenish-black, granular (mistaken by the farmers for coal; Genth, 1875, 69). *Tourmaline:* black; radiated, fibrous (Genth, 1875, 97).

JACOB SIDE'S FARM, 1/4 mile west of Mount Alverno Station. (Chester 4628). The old asbestus pits have been filled in. Meta-pyroxenite.

Enstatite: brown cleavage masses. *Amphibole asbestus:* ligniform masses; also soft, and pliable; yellowish-white (Genth, 1875, 68; Merrill, 1896, 284, 291). Occurs also on the farm to the North (Hall, 1885, 74). *Talc:* (Hall, 1885, 75).

LLEWELLYN MILLS.[157] Exposures near Llewellyn Mills, about 2 miles west of Mt. Alverno Sta. Wissahickon gneiss.

Almandite: (Dana, 1850, 655). *Staurolite:* (Dana, l. c.).

CROZIERVILLE. Exposures on the south side of Chester Creek, 1/2 mile west of Crozierville. (opposite Lenni). Wissahickon gneiss.

Amethyst: (Benge and Wherry, XIV, 1907, 5). *Tourmaline:* (Benge and Wherry, l. c.).

PETER'S MILL DAM. On Green's Creek, about 1 mile south of Chester Height's Station, P. B. & W. R. R.

Almandite:[158] deep blood red, of gem quality; occurs in the soil above the dam and in the creek bed (Dana, 1850, 655; Genth, 1875, 74; Lea, 1869, 4, notes on inclusions; Leidy, 1871, 155).

Exposures in the vicinity. Wissahickon gneiss; pegmatite; meta-pyroxenite.

Anthophyllite: (Dana, 1850, 655). *Actinolite:* (Dana, l. c.). *Beryl:* (Dana, l. c.). *Sillimanite:* (Dana, l. c.). *Muscovite:* crystals (Dana, l. c.). *Rutile:* capillary crystals in cellular quartz (Dana, l. c.).

BETHEL TOWNSHIP

CHELSEA. Old garnet mines on Green's Creek, 1 mile southwest of Chelsea (Chester 4498). Abandoned. Baltimore gneiss.

Almandite: red, massive (Genth, 1880, 311; Hall, 1885, 113, analysis). *Allophane:* silvery-white, greenish or bluish, mammillary coatings on gneiss (Harvey and Pierce). *Wad:* black, dendritic (Hall, 1885, 81).

Exposures near the garnet mines.

Cyanite: (Benge and Wherry, XIV, 1907, 6). *Talc:* (Hall, 1885, 82).

LARKIN'S FARM, 3/4 mile southwest of Chelsea, west of a branch of McCay's Run (E. branch of Naaman's Creek). Gabbro and pegmatite.

Quartz: limpid, smoky, and milky (Hall, 1885, 81). *Microcline:* (Hall, l. c.). *Almandite:* brownish-red (Hall, l. c.). *Muscovite:* crystals (Hall, l. c.). *Apatite:* (Harvey and Pierce). *Gahnite:* in muscovite (Cardeza, 1892, 197).

BUNTING'S FELDSPAR QUARRY. In the eastern corner of Bethel Township, 1 1/2 miles northwest of Boothwyn. (Chester 4846). Gabbro and pegmatite.

Microcline: crystals (Harvey and Pierce). *Beryl:* crystals measuring 10 cm. (Harvey and Pierce). *Tourmaline:* black crystals measuring 3.5 cm. long (Harvey and Pierce). *Muscovite:* green plates (Harvey and Pierce). *Autunite:* (Harvey and Pierce).

BIRMINGHAM TOWNSHIP[159]

BRANDYWINE SUMMIT. Bullock's quarry, about 1 mile S. W. of Brandywine Summit Sta. P. B. & W. R. R. Pegmatite.

Quartz: yellow crystals (Dana, 1868, 778). *Orthoclase; nacrite:* (Dana, 1850, 655). *Sillimanite:* (Dana, 1850, 655). *Zircon:* (Dana, 1850, 655). *Arsenopyrite?* (Benge and Wherry, XIII, 1906, 130).

[157] Tyson's Mill (Dana, 1850, 655).

[158] Erroneously called pyrope.

[159] Rutile crystals have been reported from this township (Dana, 1868, 778). Sharples, 1866, 271, gave an analysis of hornblende from "Birmingham township."

T. W. JOHNSON AND SON'S QUARRY, about 1 1/2 miles S. W. of Brandywine Summit Sta. and 1/2 mile west of Elam P. O. Pegmatite.

Microcline: cleavage masses (Benge and Wherry, XIII, 1906, 130; Eyerman, 1911, 3, analysis). *Kaolinite:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Biotite: lepidomelane?* (Hall, 1885, 79; Eyerman, 1911, 10; allanite reported from here proved to be biotite).

CHADD'S FORD. Near Twaddle's Paper Mill on the Brandywine, 1 1/2 miles south of Chadd's Ford.

Amethyst: (Dana, 1868, 778; Genth, 1875, 57).

CHESTER TOWNSHIP

IRVING'S QUARRY.[160] South of Ridley Creek, just east of Waterville (Chester 4644). Abandoned. Granite and pegmatite.

Microcline: crystals (Cardeza, 1892, 194). *Almandite:* fine crystals up to 4 cm. in diameter (Cardeza, l. c.). *Muscovite:* crystals in quartz (Cardeza, l. c.).

BURK'S QUARRY. Opposite Deshong's quarry; west side of Ridley Creek, 1 mile northeast of Chester Sta., B. & O. R. R. (Chester 4884). Wissahickon gneiss and pegmatite.

Microcline: (Dana, 1850, 655). *Beryl:* (Dana, l. c.). *Tourmaline:* black, (Dana, l. c.). *Spessartite:* (Dana, l. c.). *Pyrite:* (Dana, l. c.).

CROZER'S QUARRY. East side of Chester Creek, about 1/4 mile S. W. of Chester Sta., B. & O. R. R. Granite gneiss and pegmatite. Abandoned.

Microcline: (Genth, 1875, 93). *Almandite:* trapezohedra (Genth, 1875, 144). *Bismutite:* (Genth, 1875, 168). *Uraninite:* cubo-octahedra, black. *Gummite:* (Benge and Wherry, XIV, 1907, 25). *Uraconite:* (Genth, 1875, 152). *Autunite:* (Genth, 1875, 144). *Torbernite:* crystalline scales (Wherry, 1908, 68).

SHAW AND ESREY'S QUARRY. North of the B. & O. R. R., about 1/4 mile west of Chester Sta. Abandoned. Wissahickon gneiss and pegmatite.

Quartz; amethyst and *smoky:* parallel growths of smoky-purplish crystals on quartz forming plates of crystals measuring 30 × 15 × 5 cm. (Dana, 1850, 655; Genth, 1875, 57; Cardeza, 1892, 195). *Albite:* crystal aggregates (Genth, 1875, 92, analysis). *Microcline:* crystals measuring 15 × 18 cm. (Seybert, 1808, 257; Cardeza, 1892, 195). *Muscovite:* yellowish and greenish crystals (Genth, 1875, 85). *Almandite:* large crystals (Seybert, 1808, 158; Genth, 1875, 73). *Beryl:* usually altered; yellowish-green crystals (Mease, 1807, 400; Genth, 1875, 70; Eyerman, 1911, 5, analysis). *Tourmaline:* black (Cardeza, 1892, 195).

CHESTER.[161]

Albite: cleavage masses (Genth, 1875, 91). *Sillimanite:* (Thomson, 1828, 41; Erdmann 1842, 22; analyses). *Cyanite:* found in a boulder of quartz, south of the B. & O. R. R., opposite the Pennsylvania Military Academy. *Almandite:* fine dark red dodecahedra, measuring 2 cm. in diameter were found in McIlvain's quarry. *Biotite:* (Genth, 1875, 83). *Ilmenite:* (Benge and Wherry, XIV, 1907, 25). *Mirabilite:* white efflorescence on gneiss (Genth, 1875, 148).

HENVI'S QUARRY. North of Chester Creek, east of Upland, near the road to Waterville. Wissahickon gneiss and pegmatite.

Amethyst: in geodes, (near the quarry) (Dana, 1850, 655). *Microcline:* cleavage masses (Genth, 1875, 93). *Pectolite:* (Cardeza, 1892, 198). *Chabazite:* red (Palmer, 1882, 38; Cardeza, l. c.).

PETER GREEN'S FARM.[162] South of Chester Creek, 1/4 mile west of Upland Sta., West Chester Br., P. B. & W. R. R. Pits in meadow. (Chester 5763). Wissahickon gneiss and pegmatite.

Quartz: amethystine to smoky (Genth, 1875, 58). *Microcline:* (Smith, 1862, 414; Lea, 1866, 112). *Kaolinite:* (Dana, 1850, 655). *Beryl:* pale green crystals 10 cm. long (Cardeza, 1892, 195). *Tourmaline:* black (Dana, l. c.). *Sillimanite:* (Cardeza, 1892, 195), in the vicinity of the pits. *Apatite:* (Rand, 1867, 273). *Molybdenite:* crystals and foliated masses (Caren-

[160] "Bullen's Lane" of some early authors.

[161] Brown garnet and tourmaline were found in Little's Quarry, Chester; now filled in and inaccessible (Dana, 1850, 655).

[162] Smith (1862, 414) terms the locality the "old molybdena mine." Rand (1867, 273) remarks that a mine was opened for gold prior to 1848; Cardeza (1892, 195) says a copper mine was opened on the creek shore.

deffez, 1808, 96; Cleaveland, 1816, 569; Seybert, 1822, 320, analysis). *Pyrite:* (Lea, 1818, 464). *Chalcopyrite:* (Lea, 1818, 463). *Uraninite:* (observed by Rand; Genth, 1875, 43). *Molybdite:* yellowish incrustations on quartz (Genth, 1875, 54).

FELTON'S QUARRY. On Samuel Felton's farm, on Stony Run, 3/8 of a mile S. W. of Barker Sta., B. & O. R. R. (Chester 5982). Wissahickon gneiss.

Natrolite: altered (Cardeza, 1892, 195).

MCCALL'S FARM. Exposures on McCall's farm, along road on east side of Chester Creek, about 1/4 mile S. E. of Morgan Station. Wissahickon gneiss.

Amethyst: crystals (Cardeza, 1892, 198).

JOHN MULLEN'S QUARRIES. On the east side of Chester Creek, opposite Bridgewater Station, P. B. & W. R. R. Idle. Wissahickon gneiss and metagabbro. (Chester 4498).

Quartz: (Forwood, 1876, 176). *Staurolite?* (Forwood, l. c.). *Titanite:* fine yellowish-green twinned crystals, measuring 2.5 to 8 cm. The crystals were found in a loose dark brown mica schist, permeated with water, about 10 feet from the surface, associated with loose quartz crystals (Forwood, 1876, 176; Rath, 1884, 290–342). *Pyrite:* (Forwood, l. c.).

CONCORD TOWNSHIP[163]

CHESTER HEIGHTS. Quarries 1/2 mile west of Chester Heights Sta., P. B. & W. R. R. (Chester 4435). Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XIV, 1907, 6).

HANNUM'S FARM.[164] North of Green's Creek, 1 1/2 miles west of Chelsea. (Chester 4457). Meta-pyroxenite.

Anthophyllite: "antholite" yellowish-gray, broadly bladed or fibrous (Leeds, 1873, 25; Cardeza, 1892, 198; Hall, 1885, 78).

CONCORDVILLE. Exposures on the west branch of Chester Creek, 1/2 mile north of Concordville.

Hornblende: (Benge and Wherry, XIV, 1907, 6). *Garnet:* (Benge and Wherry, l. c.).

ELAM. Exposures 1/4 mile east of Elam. Meta-peridotite; Wissahickon gneiss.

Biotite: (Genth, 1875, 83). *Sepiolite:* grayish-white masses in serpentine (Genth, 1875, 112).

DARBY TOWNSHIP

CUSTER'S FARM. On Darby-Folsom Trolley Line, about 1/4 mile west of Ashland Ave., Glenolden; on Muckinipallus Creek. Wissahickon gneiss and pegmatite.

Cyanite: blue and gray bladed masses (Cardeza, 1892, 196). *Sillimanite:* (Cardeza, l. c.). *Muscovite:* (Benge and Wherry, XIII, 1907, 183). *Beryl:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Graphite?* (Benge and Wherry, l. c.). *Magnetite?* (Benge and Wherry, l. c.). *Ilmenite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Jasper:* (Benge and Wherry, l. c.).

DARBY.[165] Trolley-cut on Parker Avenue, about 1/8 mile west of Darby Creek. Pegmatite.

Microcline: (Benge and Wherry, XIII, 1907, 183). *Albite:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.).

Quarry south of Chester Pike, just west of Darby Creek. Idle. (Chester 3997). Wissahickon gneiss and pegmatite.

Quartz: crystals (Keller, 1882, 54). *Hornblende:* (Benge and Wherry, XIII, 1907, 183). *Almandite:* jet-black, with inclusions of titanite (Keller, 1882, 54, analysis; Hall, 1885, 114, analysis by Genth). *Asbestus:* (Keller, l. c.). *Muscovite:* (Keller, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Rutile:* (Rand, 1867, 272; Benge and Wherry, l. c.). *Titanite:* (Benge and Wherry, l. c.). *Pyrite:* (Keller, l. c.). *Gypsum:* efflorescences on gneiss (Rand, 1880, 253).

[163] Microcline, muscovite, spessartite, rutile, beryl, amethyst, tremolite and actinolite have been listed from the township (Dana, 1868, 778; Seybert, 1807, 405; 1823, 331).

[164] Cardeza (1892, 198) lists enstatite, antholite, and clinochlore from "Singer's farm; clinochlore, asbestus, and tourmaline from "Samuel McClellan's farm."

[165] Genth (1875, 99) described grayish, short prismatic crystals of sillimanite paramorphous after andalusite which were found in road metal on the Delaware County Turnpike.

Anhydrite was described by Koenig (1889, 11) as occurring on the diabase railroad ballast south of the B. & O. Tunnel at Darby. The original source of the material was probably Paterson, N. J.

On the Springfield Road, 200 yards from the Darby Bridge; in the vicinity of the Mt. Zion Cemetery. Wissahickon gneiss and pegmatite.

Cyanite: (Cleaveland, 1816, 202; Smith, 1862, 414).

EDGEMONT TOWNSHIP

CASTLE ROCK. On the Philadelphia-West Chester Turnpike, just west of Crum Creek. Pyroxenite and meta-peridotite.

Olivine: (Benge and Wherry, XIII, 1906, 130). *Enstatite:* (Genth, 1875, 62). *Hypersthene:* (Benge and Wherry, l. c.). *Anthophyllite:* silky, fibrous (Smith, 1862, 414; Genth, 1882, 395). *Tremolite:* white or grayish-white, with talc, a few hundred yards S. S. W. of Castle Rock (Hall, 1885, 113, analysis). *Talc;* indurated, a few hundred yards S. S. W. of Castle Rock (Genth, 1882, 394, analysis). *Serpentine:* (Benge and Wherry, l. c.). *Limonite:* (Benge and Wherry, XIII, 1906, 130). *Chalcedony:* (Eyerman, 1889, 14).

ALFRED JAI·E'S FARM, on Crum Creek, south of Castle Rock. Peridotite and meta-peridotite; Wissahickon gneiss; pegmatite.

Enstatite: (Cardeza, 1892, 201). *Asbestus:* (Cardeza, l. c.). *Talc.:* (Cardeza, l. c.). *Chrysotile:* (Cardeza, l. c.). *Quartz:* ferruginous, doubly-terminated microscopic crystals in honeycomb quartz (Cardeza, l. c.). *Goethite:* fibrous masses (Cardeza, l. c.) *Almandite:* (Benge and Wherry, XV, 1908, 108). *Beryl:* crystals (Cardeza, l. c.). *Magnetite:* (Benge and Wherry, l. c.). *Rutile:* (Benge and Wherry, l. c.).

EDGEMONT.

Staurolite: large brown twinned crystals. *Amethyst:* (Dana, 1850, 655). *Rutile:* in quartz (Dana, l. c.). *Microcline:* crystals (Dana, l. c.). *Wad:* (Dana, l. c.).

GRADYVILLE. *Quartz:* a deep smoky quartz crystal measuring 17.5 × 15 × 15 dcm. was found along the road near the Gradyville school house.

GREEN'S FARM. Two miles S. S. E. of Edgemont; east of Ridley Creek, a short distance north of the Upper Providence line.

Rutile: (Hall, 1885, 40).

WALKER YARNALL'S FARM. On Ridley Creek, $^1/_2$ mile west of Sycamore Mills. Pegmatite.

Quartz: smoky (Cardeza, 1892, 199). *Orthoclase; cassinite:* (Cardeza, l. c.). *Beryl:* yellowish-green masses.

HAVERFORD TOWNSHIP

DICKINSON'S MILL. Cut on Phila. & Western R. R. at Dickinson's Mill on Cobb's Creek, about 1 mile south of Ardmore. Wissahickon gneiss and pegmatite.

Almandite: crystals (Benge and Wherry, XIII, 1906, 131). *Staurolite:* (Benge and Wherry, l. c.). *Cyanite:* in fields in the vicinity (Benge and Wherry, l. c.). *Ilmenite:* (Benge and Wherry, l. c.).

Cut on the Phila. & Western R. R., about $^1/_2$ mile north of City Line Avenue. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XIII, 1906, 130). *Albite:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Tourmaline:* crystals (Benge and Wherry, l. c.). *Gummite* pseudo. *uraninite:* (Benge and Wherry, l. c.). *Autunite:* (Benge and Wherry, l. c.).

GRASSLAND. Exposures east of Friend's Meeting House, about 1 mile N. E. of Grassland Station, P. R. R. Wissahickon gneiss.

Almandite: (Smith, 1862, 414). *Staurolite:* (Smith, l. c.).

BROOKTHORPE. Cut on the P. R. R. at Brookthorpe Station.

Almandite: in Wissahickon gneiss (Benge and Wherry, XIII, 1906, 131).

LLANERCH. Quarry at Llanerch Sta., P. R. R. Pegmatite.

Beryl: (Benge and Wherry, XIII, 1906, 131). *Tourmaline:* (Benge and Wherry, l. c.).

ADELE. Quarry on West Chester Turnpike at Adele, just east of Darby Creek. Wissahickon gneiss and pegmatite.

Quartz; smoky: crystals (Benge and Wherry, XIII, 1906, 131). *Microcline:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.).

Exposures on Darby Creek, just south of West Chester Pike. Wissahickon gneiss and pegmatite.

Almandite: (Benge and Wherry, XV, 1908, 108). *Beryl:* (Benge and Wherry, XIII, 1906, 131). *Tourmaline:* (Benge and Wherry, XIII, 1906, 131).

Exposures[166] on east side of Darby Creek, 1/2 mile south of Adele. Wissahickon gneiss and pegmatite.

Quartz: ferruginous (Benge and Wherry, XIII, 1906, 131). *Microcline:* (Benge and Wherry, l. c.). *Almandite:* (Smith, 1862, 415). *Staurolite:* (Smith, 1862, 414). *Cyanite:* (Smith, 1862, 414). *Vermiculite; jefferisite?* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Limonite:* (Hall, 1885, 51).

LEEDOM'S QUARRY, about 1 1/2 miles south of Adele, on Darby Creek. Wissahickon gneiss.

Biotite: (Benge and Wherry, XIII, 1906, 131). *Jeffersite?* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.).

ARDMORE.

Staurolite: (Benge and Wherry, XIV, 1907, 26).

LOWER CHICHESTER TOWNSHIP

TRAINER. William Eyre's farm, on Stony Creek, 1/4 mile east of Trainer Sta., P. B. & W. R. R. Wissahickon gneiss and pegmatite.

Tourmaline: black (Dana, 1850, 655).

JOHNSON'S QUARRY, on Stony Creek, 1/4 mile east of Trainer Station. Wissahickon gneiss and pegmatite.

Almandite: (Cardeza, 1892, 197).

WILLIAM TRAINER'S FARM; on a knoll near the Linwood Mill Dam, about 1/2 mile north of Trainer Station. Pegmatite.

Quartz: limpid, smoky, and milky crystals up to 17.5 cm.; most commonly in parallel growths of smaller crystals (Harvey and Pierce). *Microcline:* crystals (Dana, 1850, 655). *Beryl:* pale green opaque crystals measuring 6.5 × 30 cm. in granular quartz boulders plowed up in the fields. Also in smaller transparent green etched crystals (Dana, 1850, 655; Cardeza, 1892, 197). *Almandite:* (Benge and Wherry, XIV, 1907, 6). *Tourmaline:* brilliant black crystals, up to 10 × 2.5 × 1.5 cm. (Dana, 1850, 655). *Cyanite:* (Benge and Wherry, l. c.). *Kaolinite:* (Dana, 1850, 655; Cardeza, 1892, 197).

PENNELL'S QUARRY, on Marcus Hook Creek, 3/8 of a mile south of Trainer Station. Wissahickon gneiss; gabbro; and pegmatite.

Almandite: (Harvey and Pierce). *Beryl:* (Harvey and Pierce). *Chabazite:* red and white (Harvey and Pierce). *Apatite:* (Harvey and Pierce).

MARPLE TOWNSHIP[167]

MORO PHILLIP'S CHROME MINE. On H. H. Battle's farm, about 1 1/2 miles southeast of Newtown Square (Chester 2432). Meta-peridotite.

Peridotite; primary: *Chromite:* massive (Lea, 1818, 466; Genth, 1875, 43). *Magnetite:* titaniferous, iron-black, massive (Genth, 1875, 39, found near the mine).

Peridotite: hydrothermal metamorphs: *Anthophyllite,* "antholite:" (Benge and Wherry, XIII, 1906, 131). *Amphibole asbestus:* (Cardeza, 1892, 201). *Chlorite; penninite, kammererite:* pink, scaly-fibrous (Genth, 1875, 131). *Talc:* (Cardeza, l. c.). *Serpentine; chrysotile:* narrow seams (Genth, 1875, 116).

Meta-peridotite; weathering products: *Quartz:* amethystine; drusy: (Benge and Wherry, l. c.). *Limonite:* (Cardeza, l. c.).

WORRELL.[168] Exposures in the vicinity of Worrell, on Crum Creek. Wissahickon gneiss; pegmatite; meta-peridotite.

Quartz: amethyst and drusy: (Dana, 1850, 655). *Beryl:* (Dana, 1850, 655). *Tourmaline:* (Dana, l. c.). *Enstatite:* Henry Hipple's farm, 3/4 miles N. N. E. of Worrell (Smith, 1862, 414;

[166] On Borden's farm, formerly Mrs. Pritchett's.

[167] The following minerals have been reported from this township without specific localities: chalcedony, agate, carnelian; ilmenite crystals, chromite (Major Jones's farm), actinolite in talc, tremolite, muscovite pseudo. andalusite, and chrysotile (Dana, 1868, 779; Genth, 1875, 36, 59; 1862, 203; Smith, 1862, 414; Rand, 1867, 205; Benge and Wherry, XIV, 1907, 26).

[168] Palmer's Mills.

Genth, 1875, 62). *Amphibole asbestus:* (Benge and Wherry, XIII, 1906, 131). *Talc:* Smith, 1862, 415). *Chromite:* (Hall, l. c.). *Magnetite;* titaniferous: (Hall, l. c.).

ABIGAIL WORRALL'S FARM. Three-quarters of a mile south of Worrell (Palmer's Mills), east of Crum Creek. Wissahickon gneiss and pegmatite.

Andalusite: crystals (Dana, 1850, 655).[169] *Almandite:* (Dana, 1850, 655). *Beryl:* (Dana, l. c.). *Tourmaline:* (Dana, l. c.). *Amethyst:* near the mansion (Cardeza, 1892, 201).

MIDDLETOWN TOWNSHIP[170]

HUMPHREY MARSHALL'S FARM. Near Dismal Run, 1/2 mile south of Sycamore Mills. Baltimore gneiss; pegmatite.

Amethyst: crystals (Cardeza, 1892, 199). *Rutile:* in amethyst crystals (Cardeza, l. c.).

JOHN TYLER'S FARM. One-quarter mile south of Marshall's farm (3/4 of a mile south of Sycamore Mills); near Dismal Run. Baltimore gneiss; Wissahickon gneiss, pegmatite.

Quartz: green and ferruginous (Cardeza, 1892, 199). *Sillimanite:* (Cardeza, l. c.). *Vermiculite:* (Cardeza, l. c.). *Rutile:* crystals (Cardeza, l. c.).

PAINTER'S FARM. On Dismal Run, 1/2 mile southwest of Tyler's farm, and 1 mile north of Lima. Baltimore gneiss and Wissahickon gneiss.

Oligoclase: yellowish, transparent cleavage masses (Genth, 1875, 90; analysis; Clarke and Schneider, 1891, 247). *Tremolite:* (Dana, 1892, 1068). *Painterite:* bright golden yellow, micaceous, in a mixture of plagioclase and serpentine (Clarke and Schneider, 1891, 247, analyses). *Tourmaline:* (Dana, l. c.). *Zircon:* minute brown crystals (Genth, 1875, 58). *Quartz:* green (Genth, 1875, 58).

SMEDLEY'S IRON MINE. On Smedley's farm, 3/4 of a mile N. E. of Lima, south of the road to Sycamore Mills. (Chester 1982). The pits have been plowed over. Residual deposits of limonite; meta-peridotite.

Corundum: (Cardeza, 1892, 200). *Quartz:* ferruginous (Benge and Wherry, XIII, 1906, 152). *Limonite; melanosiderite:* black, compact masses (Cooke, 1875, 451, analyses; Genth, 1875, 50; 1876, 215, analysis). *Goethite:* fibrous masses (Cooke, l. c.; Genth, l. c.).

GEORGE WILLIAM'S FARM. One and a half miles northeast of Lima, at the forks of the road.

Corundum: (Cardeza, 1892, 200).

JOHN SMEDLEY'S QUARRY.[171] About 1/2 mile northeast of Lima P. O. Pegmatite.

Quartz: (Genth, 1889, 50). *Albite:* (Genth, l. c.). *Almandite:* (Genth, l. c.). *Muscovite:* (Genth, l. c.) *Gahnite;* dark green crystals, 15 mm. in size, imbedded in muscovite (Genth, 1889, 50, analysis).

WILLIAM BONSALL'S FARM. One-half mile south of Lima. Meta-peridotite.

Actinolite: (Cardeza, 1892, 200). *Quartz:* drusy and smoky (Cardeza, l. c.).

ISAAC EVANS' FARM. About 1 mile N. W. of Lima, on Rocky Run. Roadside exposures.

Microcline: (Cardeza, 1892, 199). *Muscovite:* (Cardeza, l. c.).

SHARPLESS' QUARRY. About one mile east of Glen Mills Sta., P. B. & W. R. R. (Chester 1878). Pegmatite.

Quartz: microscopic crystals in muscovite (Cardeza, 1892, 199). *Microcline:* crystals up to 30 cm. long (Genth, 1875, 93). *Garnet:* red and green flattened crystals in muscovite (Cardeza, l. c.). *Beryl:* pale green, opaque, altered crystals, up to 45 cm. long. (Cardeza, 1892, 199). *Muscovite:* hexagonal crystals 25 cm. with bands of reticulated magnetite, and

[169] Andalusite is found on all the farms to the north, and those on the west side of Crum Creek in Upper Providence Township.

[170] The following indefinite localities are given by Cardeza (1892, 200-201): Edward Smedley's farm: asbestus, muscovite, talc, and corundum. Walter Green's farm: chromite (Genth, 1875, 42). Rev. Mr. Ross's farm: pyrite. Samuel Well's farm: magnetite. Matthew Dobson's farm: rutile. Near the Penna. Institute for Feeble Minded: quartz, hypersthene, and stilbite. Samuel Johnson's farm: radiated tourmaline. Charles Mill's farm: enstatite, marmolite, asbestus, and clinochlore. George Williamson's farm: corundum. Near Media: ilmenite (Genth, 1875, 36).

[171] There is a possibility of a confusion between this locality and Sharpless' quarry below. Genth stated the gahnite locality to be John Smedley's quarry, specimens having been presented to him by Cardeza. Sharpless' quarry is the only one listed by Cardeza as a locality for gahnite.

microscopic quartz crystals, more rarely with gahnite crystals (Hall, 1885, 69; Rand, 1890, 117; Cardeza, 1892, 199). *Gahnite:* small crystals in muscovite (Cardeza, 1892, 199).

In the Vicinity.

Quartz: rose (Cardeza, 1892, 199).

MINERAL HILL.[172] Exposures along the road from Media to Black Horse, just west of Ridley Creek; about 1 mile northeast of Elwyn. Wissahickon gneiss.

Sillimanite: (Genth, 1873, 381). *Cyanite:* pale bluish crystals (Genth, l. c.). *Staurolite:* brown twinned crystals (Genth, l. c.).

CRUMP'S QUARRY, MINERAL HILL; on the grounds of the Pennsylvania Training School for Feeble-Minded; 1/4 mile north of the State Road, about 1 mile west of Media. Pyroxenite and metaperidotite.

Enstatite: (Genth, 1875, 62). *Actinolite:* (Benge and Wherry, XIII, 1906, 151). *Tremolite:* (Benge and Wherry, l. c.). *Hornblende:* (Benge and Wherry, l. c.). *Serpentine, retinalite:* (Dana, 1850, 655). *Talc:* (Cardeza, 1892, 200). *Chlorite:* (Cardeza, l. c.). *Vermiculite:* (Benge and Wherry, l. c.). *Deweylite:* yellowish and brownish amorphous masses. *Chromite:* (Dana, 1850, 655). *Magnesite:* (Dana, l. c.). *Quartz:* ferruginous; weathering product (Dana, l. c.).

Small Abandoned Feldspar quarry and exposures about 1/8 mile north of Crump's quarry. Pegmatite, and meta-peridotite.

Orthoclase; delawarite; aventurine: (Rand, 1867, 274; Descloizeaux, 1868, 663). *Microcline; amazonstone:* fine green cleavage masses, rarely in distinct crystals (Dana, 1850, 655; Cardeza, 1892, 200; Descloizeaux, 1876, 433, analysis; Lea, 1866, 113, notes on inclusions). *Albite; moonstone:* (Cardeza, 1892, 200). *Oligoclase; sunstone:* (Dana, 1850, 655; Lea, 1866, 113; Descloizeaux, 1884, 272, analysis; Fouque, 1894, 371, 424). *Almandite:* (Dana, 1850, 655). *Vermiculite:* (Benge and Wherry, l. c.). *Columbite:* crystals measuring 2.5 × 1.5 cm. (Lewis, 1882, 51; Genth, 1889, 51, analysis). *Microlite:* minute grains (Benge and Wherry, XV, 1908, 109; Wherry, 1908, 70).

Exposures and stream bed nearby:

Actinolite: (Benge and Wherry, XIII, 1906, 151). *Chromite:* octahedra in the sands of the stream (Wherry). *Corundum:* (Cardeza, 1892, 200).

Exposures southwest of Crump's Quarry. Boulders in the woods, and in the bed and banks of stream. Pyroxenite, meta-peridotite, and pegmatite.

Pyroxenite; primary: *Enstatite:* (Genth, 1875, 62). *Hypersthene:* (Benge and Wherry, XIII, 1906, 152). *Chromite:* imperfect crystals (Dana, 1850, 655).

Pyroxenite; hydrothermal metamorphs: *Anthophyllite:* (Dana, 1850, 655). *Actinolite:* pale green, yellowish or brownish bladed masses; large boulders were found in the woods near the State Road, 1/2 mile southwest of Crumps quarry. (Dana, 1850, 655; Genth, 1875, 67; Eyerman, 1911, 5, analysis). *Amphibole asbestus:* (Dana, l. c.).

Pegmatite; primary: *Orthoclase:* pale green (Rand, 1871, 299). *Albite; moonstone:* blue, opalescent (Dana, 1850, 655; Lea, 1866, 111; Leeds, 1873, 25; Penfield and Sperry, 1887, 392; analyses; Descloizeaux, 1883, 110, 102, 113). *Oligoclase:* massive, occasionally crystallized; aventurine (sunstone); opalescent (moonstone). (Dana, 1850, 655; Smith and Brush, 1853, 45; Rand, 1867, 274; 1871, 299; Descloizeaux, 1884, 272, analysis; 1876, 480; Fouque, 1894, 371, 424). *Beryl:* dark greenish-blue crystals (Dana, 1850, 650; Cardeza, 1892, 200; Eyerman, 1911, 5, analysis). *Columbite:* (Cardeza, l. c.). *Fergusonite:* (Cardeza, l. c.). *Samarskite:* (Benge and Wherry, XV, 1908, 109; Wherry, 1908, 70).

BLACK HORSE.[173] John Smith's farm, at the fork of road 1/2 mile east of Black Horse. Pyroxenite, meta-pyroxenite, and pegmatite (plumasite).

Pyroxenite; primary: *Enstatite:* (Cardeza, 1892, 200).

Pyroxenite; hydrothermal metamorphs: *Actinolite:* (Cardeza, l. c.). *Hornblende:* (Cardeza, l. c.).

Pegmatite; primary: *Albite; moonstone:* (Cardeza, l. c.). *Oligoclase; sunstone:* (Car-

[172] Mineral Hill is a name commonly applied to the serpenine area west of Ridley Creek, and about 1 mile west of Media. The name has sometimes been used to include Black Horse and Elwyn, described below.

Genth lists corundum as occurring in large brown crystals, altered to margarite from the "northern slope of Mineral Hill" (Genth, 1875, 32, 136).

[173] So named from the old Black Horse Inn (now a private residence) situated at the crossing of State Road and Edgemont Road, half-way between Lima and Ridley Creek, about 2 miles west of Media.

deza, l. c.). *Tourmaline:* (Cardeza, l. c.). *Andalusite?* (Benge and Wherry, XIII, 1906, 152). *Columbite:* (Cardeza, l. c.). *Corundum:* crystals (Cardeza, l. c.).

SCHERZ'S FARM, just west of Smith's farm.

Hematite: (Cardeza, 1892, 201). *Corundum:* (Cardeza, l. c.). *Chromite:* (Cardeza, l. c.).

Quarry on Hillside, about 1/2 mile northeast of Black Horse. Pegmatite. Abandoned.

Quartz: green and ferruginous (Goodwin, 1904, 164; Benge and Wherry, XIII, 1906, 152). *Microcline:* (Benge and Wherry, l. c.). *Kaolinite:* (Benge and Wherry, l. c.).

Quarry North of State Road, 1/2 mile west of Black Horse. Granite gneiss and pegmatite. (Chester, 4321).

Quartz: crystals (Benge and Wherry, XIII, 1906, 152). *Microcline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.).

HIBBARD'S FARM, on a small tributary of Chrome Run, 3/8 mile west of Black Horse. Meta-peridotite; albite and corundum pegmatite (plumasite). (Chester 4325).

Meta-peridotite: *Bronzite:* (Cardeza, 1892, 201). *Actinolite:* (Smith, 1862, 414). *Serpentine:* (Benge and Wherry, XIII, 1906, 152). *Chlorite:* (Benge and Wherry, l. c.). *Talc;* indurated: (Eyerman, 1911, 17; analysis). *Magnesite:* stalactitic (Cardeza, l. c.).

Pegmatite (plumasite): *Albite; moonstone:* in the valley of a stream between Black Horse and the railroad; (Rand, 1867, 274). *Oligoclase;* aventurine: *sunstone;* opalescent: *moonstone;* white to yellowish, translucent (Rand, 1871, 299; Hall, 1885, 116; Eyerman, 1911, 3; analyses). *Corundum:* in albite (Cardeza, l. c.).

Placers: *Chromite:* large brilliant octahedra in sands. These sands were worked and exhausted. (Rand, 1867, 274; Genth, 1875, 42, analysis). *Brookite:* rare (Cardeza, 1892, 201). *Quartz;* ferruginous: (Benge and Wherry, l. c.).

Old Corundum pits, about 1/4 mile south of Black Horse, in field on the west side of the road to Elwyn (Chester 4334). Albite-corundum pegmatites (plumasite). Meta-peridotite.

Albite; moonstone: brownish-white, granular (Genth, 1882, 384, analysis). *Sillimanite:* [illegible] ngeries of fibrous and radiating acicular crystals, pseudomorphous after corundum, sometimes wi[illegible] a core of unaltered corundum (Genth, 1873, 380; 1875, 99; analysis). *Corundum:* white to brown slender bipyramidal crystals, 6 cm. long, often asteriated; in albite, and as loose crystals in the soil and gutters of the roads (Dana, 1850, 655; Genth, 1873, 362, 380). *Hyalite:* coating sillimanite (Genth, 1875, 373).

CASTER GREY'S FARM, 1/2 mile south of Black Horse, west of the road to Elwyn.

Anorthite? (Eyerman, 1889, 22). *Corundum:* grayish crystals in the soil and road gutters (Hall, 1885. 67; Cardeza, 1892, 200).

PHILIP MULLIN'S FARM, 3/4 of a mile southeast of Black Horse, east of the road to Elwyn.

Albite: (Benge and Wherry, XIII, 1906, 153). *Corundum:* crystals plowed up and collected after a heavy rain (Cardeza, 1892, 200).

EL[illegible] North of Elwyn Station, and near Ridley Creek.

Corundum: crystals in albite (Hall, 1885, 67).

FAIRLAMB'S FARM, 1/4 mile west of Elwyn Station.

Chromite: very brilliant octahedra, rarely modified (Genth, 1875, 42).

SCHOFIELD'S FARM, about 1/2 mile west of Elwyn Station, just west of the road to Black Horse. Pegmatite.

Oligoclase; moonstone: (Hall, 1885, 114).

Cut on the P. B. & W. R. R. about 1/2 mile west of Elwyn Station. Meta-peridotite.

Serpentine; chrysotile: (Benge and Wherry, XIII, 1906, 153).

WILLIAMSON SCHOOL.[174] Cut on the P. B. & W. R. R., 1/4 mile west of Williamson School Station. Meta-peridotite.

Olivine: (Genth, 1866, 120). *Actinolite:* (Benge and Wherry, XIII, 1906, 153). *Hornblende:* (Genth, 1866, 120). *Serpentine:* (Benge and Wherry, l. c.). *Chromite:* (Benge and Wherry, l. c.). *Magnetite:* (Genth, 1866, 120).

GLEN RIDDLE. Exposure north of P. B. & W. R. R., just east of Glen Riddle.

Quartz: smoky (Eyerman, 1889, 14). *Staurolite:* (Benge and Wherry, XIII, 1906, 153).

[174] Benge and Wherry (XIII, 1906, 153) cite the occurrence of amphibole asbestus in an abandoned and filled in pit, 1/8 mile south of Williamson School. This is probably an error. The old asbestus mines on Side's farm were situated 2 miles to the south; west of Mt. Alverno Station.

ROBERT MOSS' FARM, on Chrome Run, 1/2 mile southeast of Glen Riddle. Wissahickon gneiss.

Almandite: (Cardeza, 1892, 200). *Staurolite:* (Cardeza, l. c.).

LENNI. Cut on the P. B. & W. R. R., 3/8 mile east of Lenni Station. Meta-peridotite, and pegmatite.

Meta-peridotite: *Actinolite:* green, bladed masses (Rand, 1867, 274). *Tremolite:* (Benge and Wherry, XIII, 1906, 153). *Asbestus:* (Hall, 1885, 68). *Hornblende:* (Benge and Wherry, XIII, 1906, 153). *Serpentine; marmolite:* (Rand, 1867, 274). *Chlorite:* (Smith, 1862, 414). *Talc:* (Hall, 1885, 69). *Quartz:* green and ferruginous; weathering product (Cardeza, 1892, 201; Benge and Wherry, l. c.).

Pegmatite: *Orthoclase; lennilite* or *delawarite:* green, white, or gray, semi-transparent, (Lea, 1866, 110, notes on inclusions; Rand, 1871, 300; Genth, 1876, 224; Eyerman, 1911, 3; Benge and Wherry, l. c. "leelite") *Microcline:* green (Benge and Wherry, l. c.). *Albite; moonstone:* (Hall, 1885, 116, analysis). *Oligoclase; sunstone:* (Lea, 1866, 112, notes on inclusions). *Lennilite:* deep green, bronze-yellow, and silvery white; aggregates of rough hexagonal plates (Rand, 1867, 274; Dana, 1868, 779; Cooke and Gooch, 1875, 453, analyses; Schrauf, 1882, 350, analysis; Clarke and Schneider, 1891, 245, analyses).

Quarry north of P. B. & W. R. R., about 1/8 mile west of Lenni Station. Baltimore gneiss; hydrothermal metamorphic veins.

Orthoclase: (Benge and Wherry, XIII, 1906, 154). *Albite:* (Benge and Wherry, l. c.). *Labradorite:* bluish cleavage masses. *Hornblende:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Allanite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.).

Hydrothermal metamorphic veins: *Calcite:* crystals (Benge and Wherry, l. c.). *Apophyllite:* (Benge and Wherry, l. c.). *Chabazite:* colorless, white, and pink, twinned rhombohedra (Genth, 1876, 225; Eyerman, 1911, 12, analysis). *Laumontite:* (Benge and Wherry, l. c.). *Natrolite:* druses of prismatic crystals (Benge and Wherry, l. c.; Eyerman, 1911, 11, analysis). *Thomsonite:* druses of colorless crystals with natrolite. *Stilbite:* (Benge and Wherry, l. c.).

WAWA. On the road leading from Lima to Wawa.

Amethyst: (Cardeza, 1892, 201).

KNOWLTON.[175] One-half mile south of Knowlton, near Morgan. Wissahickon gneiss and pegmatite.

Muscovite: crystals (Rand, 1867, 274).

NETHER PROVIDENCE TOWNSHIP

FRANKLIN PAPER MILL.[176] Exposures along Crum Creek, opposite paper mill, about 1/2 mile north of Baltimore turnpike. Wissahickon gneiss and pegmatite.

Albite: (Dana, 1892, 1068). *Tourmaline:* (Dana, 1850, 655). *Muscovite:* (Dana, 1850, 655). *Ilmenite:* (Benge and Wherry, XIII, 1907, 163). *Allophane:* (Dana, 1892, 1068).

Exposures along the west bank of Crum Creek, north of Baltimore turnpike. Wissahickon gneiss and pegmatite.

Beryl: yellow (Benge and Wherry, XIII, 1907, 163). *Almandite:* (Benge and Wherry, l. c.).

LEWIS' FARM. On a small run, 1 mile southeast of Media. Wissahickon gneiss and pegmatite.

Beryl: yellow (Cardeza, 1892, 196). *Tourmaline:* (Cardeza, l. c.). *Andalusite:* large crystals (Cardeza, l. c.).

Opposite Swarthmore College. Exposures along west bank of Crum Creek, above P. B. & W. R. R. bridge, opposite Swarthmore College. Wissahickon gneiss and pegmatite.

Microcline: (Cardeza, 1892, 196). *Tourmaline:* black tapering crystals (Cardeza, l. c.). *Andalusite:* (Genth, 1875, 98).

AVONDALE.[177] Quarry on west side of Crum Creek, just south of Avondale. (Chester 5615). Abandoned. Granite gneiss and pegmatite.

[175] The "Dutton's Mill" locality for muscovite. The other minerals were found west of Chester Creek, in Aston township.

[176] Formerly Lewis' paper mill.

[177] Many of the minerals found in Leiper's quarry (described below under Springfield township) were found here.

Microcline: (Benge and Wherry, XIII, 1907, 163). *Almandite:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.).

SHARPLESS' QUARRY. On the farm of George Sharpless, on a small creek, 1 mile west of Avondale; and 3 miles north of Chester. Wissahickon gneiss and pegmatite.

Microcline: doubly terminated crystals measuring 40 × 30 cm. (Cardeza, 1892, 196). *Muscovite:* green crystals (Cardeza, l. c.). *Amethyst:* a pocket of deep purple crystals, up to 5 cm. in diameter, was found in digging a post hole opposite the mansion (Cardeza, 1892, 196).

WATERVILLE.

Chabazite: (Palmer, 1882, 38).

CROSSBYVILLE.

Microcline: (Hall, 1885, 92).

NEWTOWN TOWNSHIP[178]

NEWTOWN SQUARE.[179] Exposures on West Chester Pike, 1 mile west of Newtown Square.

Oligoclase; moonstone: (Benge and Wherry, XIII, 1906, 130). Also found in the fields 1/2 mile east of Newtown Square.

WEST CHESTER PIKE, 3/4 mile west of Newtown Square, at fork of road. Meta-peridotite.

Meta-peridotite; weathering products: *Quartz:* pseudomorphous after serpentine; cavities are filled with colorless, bright yellow and red crystals loose in a mud (Rand, 1887, 1571). *Goethite:* fibrous masses (Rand, 1887, 1571).

Outcrop of serpentine, on West Chester pike, 1 mile east of Newtown Square. Meta-peridotite.

Quartz: drusy and stalactitic; weathering product of serpentine (Rand, 1887, 1610; Hall, 1885, 35).

South of Newtown Square, close to Hunter's Run, and near the southern township line. Meta-pyroxenite.

Tremolite: fibrous masses (Hall, 1885, 36). *Talc:* (Hall, l. c.).

RADNOR TOWNSHIP[180]

ST. DAVID'S. Schmidt's farm, 3/4 mile north of St. David's Sta., P. R. R. Wissahickon gneiss.

Almandite: (Benge and Wherry, XIII, 1906, 129). *Staurolite:* (Benge and Wherry, l. c.).

Quarry on Frank Fennimore's farm, 1/4 mile north of St. David's Station. Wissahickon gneiss.

Almandite: rounded crystals (Genth, 1875, 73). *Staurolite:* (Benge and Wherry, XIII, 1906, 129).

RADNOR. John Stacker's quarry, about 1/2 mile northwest of Radnor Station, on the road to King of Prussia. Pyroxenite and meta-peridotite.

Primary minerals: *Enstatite:* (Rand, 1892, 186). *Chromite:* (Rand, 1880, 273; 1892, 186).

Hydrothermal metamorphs: *Amphibole asbestus; mountain-cork:* (Rand, 1892, 186). *Serpentine; marmolite, chrysotile:* (Rand, l. c.).

Weathering products: *Vermiculite:* (Rand, l. c.). *Deweylite:* (Rand, l. c.). *Sepiolite:* pseudo. quartz (Rand, l. c.). *Genthite; pimelite?* (Rand, l. c.). *Quartz:* drusy, pseudomorphous after serpentine and asbestus (Rand, l. c.). *Chalcedony; cachalong:* (Rand, 1892, 186).

GILLINGHAM'S FARM, about 1/2 mile northeast of Radnor Station. Wissahickon gneiss.

Almandite: (Benge and Wherry, XIII, 1906, 129).

Cut on P. R. R. about 1/2 mile east of Radnor Station. Baltimore gneiss and gabbro.

Labradorite: (Benge and Wherry, XII, 1906, 129); *Hypersthene:* (Benge and Wherry, l. c.).

[178] Smith (1862, 414) lists enstatite and tremolite, as occurring "near old lime-kiln on West Chester pike." Chrysotile, chromite, and hematite are also reported from the township (Benge and Wherry, XIV, 1907, 26).

[179] Rand (1880, 276) lists muscovite from "Newtown Square."

[180] Elongated pyrite cubes occur in the limestone of the Cream Valley, 1 mile north of Radnor. Almandite and staurolite occur in Wissahickon gneiss in this valley (Rand, 1892, 186).

The following indefinite localities have been listed: Yellow Springs Road: magnestite and serpentine (Smith, 1862, 414). Near Morgan's Corner: asbestus (Hall, 1885, 31). Near Friend's Meeting House, Radnor: blue quartz, and almandite (Smith, 1862, 414). Near Evan's Schoolhouse: blue quartz (Smith, 1862, 414). West of Darby Creek, and south of Fawke's Run: enstatite (Hall, 1885, 31).

Quarry on Rand's farm, 1 mile south of Radnor Station. Meta-peridotite.

Serpentine: (Benge and Wherry, XIII, 1906, 129). *Asbestus:* (Benge and Wherry, l. c.). *Pimelite?* (Goldschmidt, 1893, 174).

THE HUNT. Mary Palmer's farm, north of The Hunt Station, P. R. R. Pyroxenite.

Enstatite: (Cardeza, 1892, 199). *Bronzite:* (Cardeza, 1892, 198). *Hypersthene; diaclasite:* (Cardeza, 1892, 198). *Anthophyllite, "antholite:"* (Cardeza, 1892, 199; 202).

Roadside exposures and railroad cut, about 1/2 mile west of The Hunt Station. Meta-peridotite.

Anthophyllite, "antholite:" (Benge and Wherry, XIII, 1906, 129). *Amphibole asbestus:* (Cleaveland, 1822, 624). *Serpentine; retinalite, chrysotile:* (Benge and Wherry, l. c.). *Chlorite; kammererite:* (Benge and Wherry, l. c.). *Sepiolite:* (Benge and Wherry, l. c.). *Deweylite:* (Benge and Wherry, l. c.; Eyerman, 1911, 17, analysis). *Chromite:* (Cleaveland, 1822, 624). *Magnetite:* (Cleaveland, l. c.). *Limonite:* (Cleaveland, l. c.). *Quartz;* drusy, stalactitic (Benge and Wherry, l. c.). *Jasper:* (Benge and Wherry, l. c.).

RIDLEY TOWNSHIP

FOLSOM. Quarry on Stony Creek, at Folsom, just south of Darby-Media Trolley Line. Abandoned. Granite gneiss and pegmatite.

Almandite: large crystals up to 7.5 cm. (Cardeza, 1892, 194).

MOORE. Fields in the vicinity of the old White Horse Tavern, on the Philadelphia-Chester Turnpike, 3/8 mile east of Stony Creek, and about 3/8 mile south of Moore Sta., P. B. & W. R. R. Wissahickon gneiss and pegmatite.

Beryl: prismatic crystals in cyanite: (Genth, 1875, 71). *Cyanite:* blue radiating bladed masses; gray or grayish-black crystals (Lea, 1818, 479); Genth, 1875, 101; Eyerman, 1911, 7, analysis). *Sillimanite:* yellowish fibrous masses (Genth, 1875, 99). *Damourite:* (Benge and Wherry, XIII, 1907, 183). *Pyrite:* (Genth, 1875, 101).

RIDLEYVILLE. Bed and banks of Ridley Run, near Darby Creek, 1 mile south of Moore Sta. Wissahickon gneiss, and pegmatite.

Almandite: (Dana, 1850, 655). *Cyanite:* colorless and deep blue bladed masses (Lea, 1818, 479; Dana, 1850, 655; Smith, 1862, 414). *Sillimanite:* (Dana, l. c.). *Damourite:* (Dana, l. c.).

AVONDALE. Quarry on east side of Crum Creek, just southeast of Avondale. (Chester 5612). Granite gneiss, and pegmatite. Abandoned.

Microcline: (Benge and Wherry, XIII, 1907, 183). *Almandite:* crystals (Benge and Wherry, l. c.). *Beryl:* crystals (Benge and Wherry, l. c.). *Tourmaline:* black prisms (Benge and Wherry, l. c.). *Columbite:* crystals (Benge and Wherry, l. c.).

WARD'S QUARRY. East side of Crum Creek, about 1/2 mile southeast of Crum Lynne Station, P. B. & W. R. R. (Chester 6446). Idle. Granite gneiss and pegmatite; hydrothermal metamorphic veins, in shear zones in the gneiss.

Pegmatite; primary minerals: *Orthoclase:* (Benge and Wherry, XIII, 1907, 183). *Microcline:* green and pink (Benge and Wherry, l. c.). *Albite:* greenish crystals. *Oligoclase:* (Benge and Wherry, l. c.). *Hornblende:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l c.). *Biotite:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Cyanite:* (Genth, 1875, 101). *Tourmaline:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Molybdenite:* traces.

Granite gneiss; hydrothermal metamorphs: *Calcite;* argentine: white pearly, lamellar (Gordon, 1916, 55). *Stilbite:* yellowish radiations (Cardeza, 1892, 194). *Heulandite:* yellow tabular crystals (Gordon, l. c.). *Natrolite:* white, radiating needles. *Mesolite:* mealy white radiations (Gordon, l. c.). *Laumontite:* white and yellow small prismatic crystals, usually in radiating aggregates (Gordon, l. c.).

LEIPERVILLE.[181] Deshong's quarries on the east side of Ridley Creek, about 1/2 mile west of Leiperville. (Chester 5685). Wissahickon gneiss, granite gneiss, pegmatite, and hydrothermal metamorphic veins in shear zones.

Pegmatite; primary minerals: *Quartz:* colorless or smoky crystals (Genth, 1875, 109;

[181] Dana (1844, 388; 1850, 655) listed muscovite, tourmaline, andalusite, cyanite, and apatite from "on the edge of a wood, near Leiper's Church, Leiperville."

Benge and Wherry, XIII, 1907, 184). *Microcline:* large crystals up to 25 cm. long (Rand, 1867, 273). *Albite:* (Dana, 1850, 655; Benge and Wherry, l. c.). *Oligoclase:* (Benge and Wherry, l. c.). *Beryl:* blue, green, and yellow; translucent to transparent crystals, measuring up to 30 × 5 cm. (Dana, 1844, 393; Genth, 1875, 70). *Tourmaline:* black crystals measuring 12 × 3 cm.; often stellate or radiated; rarely pale green and red, in albite (Dana, 1844, 393; Genth, 1875, 97). *Almandite:* red crystals measuring 2.5 cm. *Grossularite:* yellow, and green, massive, granular; dodecahedra; (Koenig, 1878, 81; Eyerman, 1911, 6; analyses). *Zoisite; thulite:* rose red to pale pink; massive, cryptocrystalline; aggregates of small crystals (Koenig, 1878, 83; Eyerman, 1911, 8, analysis). *Muscovite:* (Silliman, Jr., 1850, 378). *Biotite:* (Benge and Wherry, l. c.). *Apatite:* crystals (Dana, 1844, 545). *Ilmenite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Titanite:* (Dana, 1850, 655).

Pegmatite; hydrometamorphs: *Gummite:* (Eyerman, 1911, 23). *Uraconite:* (Benge and Wherry, l. c.). *Autunite:* (Genth, 1875, 144). *Torbernite:* minute green scales (Rand, 1867, 273; Genth, 1875, 144).

Hydrothermal metamorphic veins: *Stilbite:* yellowish-brown, radiating (Genth, 1875, 109). *Heulandite:* (Koenig, 1878, 84). *Chabazite:* (Koenig, 1882, 288). *Natrolite:* (Dana, 1850, 655). *Thomsonite:* radiating aggregates (Koenig, 1882, 288). *Chlorite:* (Benge and Wherry, XIII, 1907, 184). *Saponite?* (Rand, 1867, 273). *Leidyite:* green, waxy, botryoidal coatings (Koenig, 1878, 84). *Siderite:* grayish to brownish, granular (Genth, 1875, 100).

SPRINGFIELD TOWNSHIP[182]

SPRINGFIELD QUARRY. One-eighth mile north of Saxer Avenue Station, Phila. & Western R. R. (Chester 2966). Granite gneiss and pegmatite. Idle.

Ilmenite: (Benge and Wherry, XIII, 1907, 162). *Opal, hyalite:* (Benge and Wherry, l. c.).

MORTON. Johnson's quarry, one-half mile north of Morton, on the road from Morton to Marple. Idle. Granite gneiss and pegmatite.

Microcline: crystals (Benge and Wherry, XIII, 1907, 162). *Albite:* crystals (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Tourmaline:* black (Benge and Wherry, l. c.). *Allanite:* (Benge and Wherry, l. c.). *Epidote:* (Benge and Wherry, XV, 1908, 109). *Muscovite:* (Benge and Wherry, XIII, 1907, 162). *Biotite:* (Benge and Wherry, XIII, 1907, 162). *Titanite:* (Benge and Wherry, XV, 1908, 109). *Apatite:* (Benge and Wherry, XIII, 1907, 162). *Columbite:* (Benge and Wherry, XIII, 1907, 162). *Euxenite:* (Law and Wherry, 1907, 33). *Magnetite:* (Benge and Wherry, XV, 1908, 109). *Ilmenite:* (Benge and Wherry, XIII, 1907, 162). *Molybdenite:* (Benge and Wherry, XIII, 1907, 162). *Pyrite:* (Benge and Wherry, XIII, 1907, 162). *Bindheimite?* (Benge and Wherry, XIII, 1907, 162). *Opal, hyalite:* (Benge and Wherry, XIII, 1907, 162).

FRANKLIN PAPER MILLS.[183] On Crum Creek, 1 mile E. N. E. of Media. Wissahickon gneiss and pegmatite.

Staurolite: (Dana, 1850, 655). *Apatite:* (Dana, l. c.).

Exposures on the east bank of Crum Creek, 1/4 mile northeast of Franklin Paper Mills. Wissahickon gneiss and pegmatite.

Albite: crystals (Benge and Wherry, XV, 1908, 109). *Beryl:* blue, green, yellow (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Andalusite:* crystals (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.).

Roadside exposures on east side of Crum Creek, about 1/4 mile north of Baltimore turnpike. Meta-gabbro, and pegmatite.

Orthoclase: (Benge and Wherry, XIII, 1906, 162). *Albite:* crystals (Benge and Wherry, l. c.). *Hornblende:* (Benge and Wherry, l. c.). *Beryl:* yellow (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Uraninite:* (Benge and Wherry, l. c.). *Molybdenite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Gummite:* (Benge and Wherry, l. c.). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.).

BAIN'S QUARRY. East of Crum Creek, 1/8 mile north of Baltimore turnpike. Meta-gabbro.

[182] Dana (1850, 655) listed garnet and beryl from "Fell's Laurel Hill."

[183] Formerly Lewis' paper mills; Beattie's Mill. For list of minerals occurring west of Crum Creek, see Nether Providence Township, above.

Albite: crystals (Benge and Wherry, XIII, 1907, 162). *Hornblende:* (Benge and Wherry, l. c.). *Epidote:* (Benge and Wherry, l. c.).

SWARTHMORE.[184] Exposures along east bank of Crum Creek, south of Baltimore turnpike. Wissahickon gneiss.

Almandite: (Benge and Wherry, XIII, 1907, 162). *Andalusite:* good finely modified crystals; occurs also 1/2 mile north of Swarthmore Station (Dana, 1850, 655; Smith, 1862, 415; Genth, 1875, 98; Hall, 1885, 89).

Exposures along Crum Creek, south of the P. B. & W. R. R. bridge. Wissahickon gneiss.

Andalusite: crystals (Benge and Wherry, XIII, 1907, 162).

STRATH HAVEN INN. Quarry east of Crum Creek, on the Darby-Media Trolley Line, near Strath Haven Inn. Abandoned. Granite gneiss and pegmatite. (Chester 5375).

Microcline: crystals (Benge and Wherry, XIII, 1907, 162). *Almandite:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Ilmenite:* crystals (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Chrysocolla:* (Benge and Wherry, l. c.).

AVONDALE. Leiper's quarry at Avondale, on the east side of Crum Creek, 1/2 mile south of Darby-Media Trolley Line. (Chester 5378). Granite gneiss and pegmatite.

Quartz: crystals (Benge and Wherry, XIII, 1907, 163). *Orthoclase; adularia:* colorless crystals (Hall, 1885, 118, analysis by Genth). *Microcline:* pink crystals (Dana, 1850, 655; Genth, 1882, 392, analysis; Hall, 1885, 118). *Albite:* colorless or white, short stout twinned crystals; on microcline, or in miarolitic cavities with white beryl, tourmaline, and calcite (Genth, 1882, 392; analysis; Hall, 1885, 117). *Oligoclase:* (Genth, 1882, 393, analysis; Hall, 1885, 117). *Beryl:* green, yellow; white or colorless modified crystals in miarolitic cavities with albite and tourmaline (Genth, 1882, 392). *Spessartite:* brilliant red crystals, forms (110) and (211), up to 6 cm. in diameter (Dana, 1850, 655; Genth, 1875, 73; Rath, 1884, 301; Robinson, 1887, 251, analysis; Gratacap, 1912, 202). *Andalusite:* (Benge and Wherry, XIII, 1907, 163). *Epidote:* (Benge and Wherry, l. c.). *Zoisite, thulite:* pink (Cardeza, 1892, 194). *Axinite:* yellow plates, (Wherry, 1915, 509, analysis). *Tourmaline:* black prismatic crystals, often in sections cemented by quartz, or with quartz cores (Dana, 1850, 655; Eyerman, 1911, 10, analysis). *Muscovite:* crystals (Dana, 1850, 655; Genth, 1882, 392). *Biotite:* (Benge and Wherry, l. c.). *Chlorite:* (Benge and Wherry, l. c.). *Stilbite:* yellow (Benge and Wherry, l. c.). *Chabazite:* red rhombohedra (Benge and Wherry, l. c.). *Zircon; cyrtolite:* minute crystals (Wherry, 1908, 68). *Titanite:* (Benge and Wherry, XV, 1908, 109). *Apatite:* crystals (Dana, 1850, 655). *Uraninite:* crystals (Rand, 1867, 273). *Magnetite:* (Benge and Wherry, XIII, 1907, 163). *Ilmenite:* (Benge and Wherry, l. c.). *Molybdenite:* minute hexagonal crystals (Benge and Wherry, XIII, 1907, 163). *Bismuthinite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Calcite:* small scalenohedra, or cleavage masses (Genth, 1882, 392).

Pegmatite: weathering products: *Opal, hyalite:* green, mammillary (Genth, 1875, 61). *Allophane:* green (Benge and Wherry, XIII, 1907, 163). *Bismutite:* (Rand, 1867, 273). *Malachite:* (Cardeza, 1892, 194). *Chrysocolla:* (Cardeza, 1892, 194). *Uranophane:* (Benge and Wherry, l. c.). *Gummite:* yellow, often with a core of uraninite (Wherry, l. c.). *Torbernite:* green scales (Wherry, l. c.). *Autunite:* yellow scales (Rand, 1867, 273). *Uraconite:* (Rand, 1867, 273).

THORNBURY TOWNSHIP

GLEN MILLS.

Albite: greenish-gray, rarely opalescent (Dana, 1868, 779; Genth, 1875, 91; Hall, 1885, 44). *Amethyst:* (Dana, 1868, 779).

UPPER CHICHESTER TOWNSHIP

BOOTHWYN. J. B. Okie's farm, about 2 miles north of Boothwyn, east of Chelsea-Boothwyn Road. Gabbro and pegmatite.

Amethyst: purple crystals measuring 2.5 cm. (Cardeza, 1892, 197). *Tourmaline:* black crystals (Harvey and Pierce).

Roadside exposures on the Chelsea-Boothwyn road.

[184] Formerly Westdale.

Limonite pseudo. *pyrite:* (Benge and Wherry, XIV, 1907, 7).

THATCHER'S FARM, 1 1/2 mile north of Boothwyn. Gabbro and pegmatite.

Quartz: a limpid crystal measuring 25 cm. long was found in digging a post-hole in the cowyard of the barn (Harvey and Pierce).

ARMSTRONG'S FARM, 1/2 mile north of Boothwyn, east of the Chelsea Road. Gabbro and pegmatite.

Quartz: smoky to amethystine crystals measuring 5 cm., in parallel growths (Harvey and Pierce). *Beryl:* green crystals measuring 7.5 × 30 cm. (Harvey and Pierce). *Tourmaline:* slender black crystals, 10 cm. long (Harvey and Pierce). *Zircon; cyrtolite:* small crystals (Harvey and Pierce).

BERGDOLL'S FARM, immediately north of Boothwyn Station, west of Chelsea Road. Gabbro and pegmatite.

Amethyst: light purple crystals, usually in parallel growths, in the soil.

BULLOCK'S QUARRY, on Marcus Hook Creek, 1/2 mile east of Boothwyn Sta., B. & O. R. R. Pegmatite.

Microcline: (Harvey and Pierce). *Beryl:* (Harvey and Pierce). *Almandite:* (Harvey and Pierce). *Muscovite:* enclosing magnetite (Harvey and Pierce). *Apatite:* green, massive (Harv y and Pierce). *Monazite:* brown, small crystals in apatite. *Columbite:* crystals measuring 4 × 2 cm. (Harvey and Pierce).

MCCAY'S QUARRY, on E. branch of Naaman's Creek, 1/4 mile west of Boothwyn Station. Pegmatite.

Quartz: (Benge and Wherry, XIV, 1907, 7). *Microcline:* (Benge and Wherry, l. c.). *Spessartite?* crystals measuring 2.5 cm. (Cardeza, 1892, 197).

One half mile west of Boothwyn Station.

Orthoclase: crystals measuring 5 cm. (Harvey and Pierce). *Quartz:* large groups of crystals, stained reddish, in parallel position (Harvey and Pierce).

MCCAY'S FARM.

Quartz: fine rutilated crystals in the soil (Harvey and Pierce).

Washout along north side of B. & O. R. R., just west of the E. branch of Naaman's Creek, 3/8 mile S. W. of Boothwyn Station. Gabbro and pegmatite.

Almandite: red dodecahedra and trapezohedra, single crystals measuring 1 to 6 cm. (Cardeza, 1892, 197). *Titanite:* brilliant green and yellow transparent to translucent crystals measuring 2.5 cm. in length, (Cardeza, 1892, 197).

Feldspar pits on the west side of the E. branch of Naaman's Creek, between the B. & O. R. R. and the Boothwyn road, about 1/2 mile S. W. of Boothwyn Station. Abandoned. (Chester 7235). Pegmatite.

Quartz: crystals (Benge and Wherry, XIV, 1907, 7). *Microcline:* crystals (Benge and Wherry, l. c.). *Albite:* (Benge and Wherry, l. c.). *Almandite:* red crystals (Benge and Wherry, l. c.; Law, 1904, 57). *Beryl:* yellow and green (Benge and Wherry, l. c.). *Andalusite?* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Zircon; cyrtolite:* brown and yellow, minute crystals (Benge and Wherry, l. c.; Wherry, 1908, 72). *Apatite:* green (Wherry). *Monazite:* brown, translucent crystals, sometimes twinned, measuring up to 2.5 × 2.5 × 1 cm. (Harvey and Pierce; Wherry, 1919, 123). *Xenotime:* minute crystals (Benge and Wherry, l. c.). *Columbite:* crystals measuring 3 cm. in length (Benge and Wherry, l. c.; Smith, 1919, 121). *Samarskite:* (Wherry).

Pegmatite; weathering products: *Vermiculite:* (Benge and Wherry, l. c.). *Lithomarge:* (Benge and Wherry, l. c.). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.).

Feldspar quarry, and exposures in the bed of a small stream adjacent to the quarry, on the east side of the E. branch of Naaman's Creek, 3/4 mile S. S. W. of Boothwyn Station, and 1/4 mile south of the Boothwyn road (Chester 7239). Abandoned. Other pits are located along the hillside to the east, and on the west side of the creek, near the road. Pegmatite.

Quartz: crystals (Benge and Wherry, XIV, 1907, 6). *Microcline:* crystals measuring 30 cm. (Benge and Wherry, l. c.). *Albite:* (Benge and Wherry, l. c.). *Almandite:* crystals up to 7.5 cm. (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Zircon: cyrtolite:* (Harvey and Pierce).

GEORGE HELM'S FARM, 1 mile southwest of Boothwyn, between the east and middle branches of Naaman's Creek. Pegmatite.

Almandite: black crystals measuring 2 cm. (Harvey and Pierce).

UPPER DARBY TOWNSHIP[185]

UPPER DARBY. Cut on the Phila. & Western R. R. about 1/8 mile S. E. of City Line Avenue. Wissahickon gneiss and pegmatite.

Quartz: crystals (Benge and Wherry, XIII, 1907, 161). *Almandite:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Kaolinite:* (Benge and Wherry, l. c.).

Exposures along West Chester pike, and in the adjacent field, 1/2 mile west of Upper Darby P. O. Wissahickon gneiss and pegmatite.

Quartz: colorless to smoky, large crystals (Smith, 1862, 414). *Almandite:* crystals (Benge and Wherry, XIII, 1907, 161). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* large sheets (Benge and Wherry, l. c.). *Kaolinite:* (Benge and Wherry, l. c.). *Aquacreptite?* (Benge and Wherry, l. c.). *Limonite* pseudo. *pyrite:* large crystals (Benge and Wherry, l. c.).

DREXEL'S QUARRY. Just northwest of Garrett Road Station, P. R. R. Granite gneiss and pegmatite.

Almandite: (Benge and Wherry, XIII, 1907, 161). *Molybdenite:* crystals (Benge and Wherry, l. c.). *Hyalite:* weathering product (Benge and Wherry, l. c.).

LANSDOWNE. Mahoney's Sand Pit, 1/4 mile west of Owen Avenue, and 1/8 mile north of Greenwood Avenue, in the northwestern part of Lansdowne. Granite gneiss and pegmatite.

Quartz: fine smoky crystals up to 18 × 23 cm. (Cardeza, 1892, 196; Goodwin, 1909, 15). *Muscovite:* crystals (Benge and Wherry, XIII, 1907, 161).

BURMONT. Mahoney's quarry, on Darby Creek, 1/4 mile east of Burmont Sta., P. B. & W. R. R. Wissahickon gneiss and pegmatite.

Quartz: smoky crystals in the road cuts nearby (Benge and Wherry, XIII, 1906, 161). *Almandite:* crystals (Benge and Wherry, XIII, 1906, 161).

KELLYVILLE. Maher's quarry, 1/4 mile north of Baltimore Avenue, at fork of road, in eastern part of Kellyville. Granite gneiss and pegmatite. Abandoned.

Quartz: smoky crystals (Smith, 1862, 414). *Microcline:* (Benge and Wherry, XIII, 1907, 162). *Almandite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Sillimanite:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.).

GILLESPIE'S QUARRY. On the north side of Darby Creek, just west of Garrett Road trolley bridge. Granite gneiss and pegmatite.

Quartz: crystals (Benge and Wherry, XIII, 1907, 162). *Microcline:* (Benge and Wherry, l. c.). *Albite:* (Benge and Wherry, l. c.). *Oligoclase:* (Eyerman, 1911, 3, analysis). *Hornblende:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Muscovite:* crystals (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Hyalite:* weathering product (Benge and Wherry, l. c.).

UPPER PROVIDENCE TOWNSHIP[186]

BLUE HILL.[187] Exposures at Blue Hill cross-roads, about 2 1/2 miles northwest of Media, and 3/4 mile northeast of Sycamore mills. Meta-peridotite and pegmatite.

Meta-peridotite: *Enstatite, bronzite:* (Dana, 1892, 1068). *Hypersthene, diaclasite:* (Dana, l. c.). *Anthophyllite:* (Dana, 1850, 655). *Tremolite:* (Smith, 1862, 414). *Actinolite:* (Smith, l. c.). *Asbestus:* (Dana, 1850, 655). *Chlorite; clinochlore:* (Dana, 1868, 779; 1892, 1968). *Serpentine, picrolite; chrysolite,* fibrous seams in massive serpentine (Dana, 1850, 655; Genth, 1862, 203; Benge and Wherry, XIII, 1906, 132). *Talc:* green, foliated (Dana, 1850, 655). *Apatite:* (Dana, 1892, 1068). *Chromite:* octahedra measuring 5 mm. (Rand, 1867, 275). *Zircon:* (Genth, 1875, 77). *Quartz:* blue and green, perfect doubly terminated crystals, usually in aggregate or radiated masses, loose in the soil, rarely in green talc or chlorite; also ferruginous and amethystine (Dana, 1850, 655; Smith, 1862, 415; Benge and Wherry, l. c.).

[185] Smith (1862, 415) reported garnet from "George Smith's quarry, Upper Darby," and beryl from "Upper Darby." Cardeza (1892, 196) listed quartz and microcline from "cutting of the Chester Co. R. R."

[186] Hall (1885, 111) gives an analysis by Genth of a black titaniferous magnetite enclosing rutile from "Mary Worral's farm." Smith (1862, 414) lists amethyst, tourmaline, and andalusite from the "Rock House."

[187] Smith (1862, 415) reports spinel, but Col. Willcox (Hall, 1885, 60) considered this an error.

Pegmatite: *Orthoclase; delawarite; cassinite:* dull bluish-green, vitreous, semi-transparent, with internal reflections due to minute, but visible hexagonal plates (Lea, 1866, 110; Rand, 1871, 300; Leeds, 1870, 63, analysis; Genth, 1876, 224, analysis; Penfield and Sperry, 1888, 326, analysis, and optical examination). *Oligoclase:* transparent, white, striated (Genth, 1876, 223, analysis).

SYCAMORE MILLS.[188] Roadside exposures just east of Sycamore Mills, on Ridley Creek, 2 miles northwest of Media. Wissahickon gneiss and pegmatite.

Microcline: (Genth, 1875, 73). *Almandite;* manganiferous: dark reddish-brown crystals measuring 10 cm. (Smith, 1862, 415; Genth, 1875, 73; Eyerman, 1911, 6, analysis; Benge and Wherry, XIII, 1906, 132). *Muscovite:* plumose (Cardeza, 1892, 199).

REESE'S FARM, on Ridley Creek, just east of Sycamore Mills. Pegmatite.

Orthoclase; cassinite: (Cardeza, 1892, 197). *Albite:* moonstone: (Cardeza, l. c.). *Oligoclase; sunstone:* (Smith, 1862, 414; Cardeza, l. c.). *Corundum:* (Cardeza, l. c.).

ROSE TREE.[189] Smedley's asbestus mine, 1/2 mile west of Rose Tree, in a field just north of the road to Sycamore Mills (Chester 2725). Pyroxenite and meta-pyroxenite.

Enstatite: brown, cleavage masses. *Anthophylite:* radiated (Benge and Wherry, XV, 1908, 108). *Asbestus:* white, fibrous masses (Benge and Wherry, XIII, 1906, 132). *Chlorite:* (Benge and Wherry, XV, 1908, 108).

Exposures in bed of a small tributary of Ridley Creek, about 1/2 mile W. S. W. of Rose Tree. Pyroxenite; meta-pyroxenite, and meta-peridotite.

Enstatite: (Benge and Wherry, XV, 1908, 108). *Anthophyllite; "antholite:"* also occurs in a quarry on the top of hill 1/4 mile south (Benge and Wherry, XV, 1908, 108; XIII, 1906, 132). *Serpentine:* (Benge and Wherry, XV, 1908, 108). *Talc,* pseudomorphous after anthophyllite: (Benge and Wherry, XV, 1908, 108).

JAMES WORRAL'S FARM. On Crum Creek, 1 mile east of Rose Tree Inn, and 1 1/2 miles northeast of Media. Wissahickon gneiss, pegmatite, and amethyst veins.

Amethyst: deep purple crystals, in groups measuring up to 6 × 25 cm. Also found across the creek in Marple township. (Rand, 1867, 275; Cardeza, 1892, 199). *Microcline:* (Benge and Wherry, XIII, 1906, 132). *Beryl:* (Cardeza, 1892, 199). *Almandite:* (Benge and Wherry, l. c.). *Tourmaline:* (Cardeza, 1892, 199). *Andalusite:* large crystals measuring up to 6 × 23 cm., and, in groups weighing up to 60 pounds. Crystals have an irregular cleavage, and some show a fibrous or radiating structure indicating paramorphs of sillimanite after andalusite (Rand, 1867, 275; Dana, 1844, 545; 1868, 779; 1872, 273; 1892, 497; Genth, 1875, 99). *Ilmenite:* (Benge and Wherry l. c.). *Rutile:* (Benge and Wherry, l. c.).

MORGAN HUNTER'S FARM. Just west of Worral's farm. Wissahickon gneiss, pegmatite, and amethyst veins.

Amethyst: deep purple crystals up to 7 pounds (Dana, 1850, 655; Kunz, 1890, 114, plate 6). *Tremolite;* pseudo. *andalusite?* (Cardeza, 1892, 199). *Andalusite:* (Cardeza, l. c.). *Muscovite:* pseudo. *Andalusite?* (Cardeza, l. c.).

RANDOLPH'S FARM. Just west of Hunter's farm. Wissahickon gneiss and amethyst veins.

Amethyst: in the soil, with wad (Cardezza, 1892, 199).

COPPLE'S FARM. One-half mile east of Media Reservoir.

Amethyst: (Benge and Wherry, XV, 1908, 108).

FAYETTE COUNTY[190]

DUNBAR.

Quartz: doubly terminated crystals (Lewis, 1880, 242). *Siderite:* crystals in massive siderite (Lewis, l. c.). *Pyrite:* minute crystals (Lewis, l. c.)

VICTORIA.

Galena: (Eyerman, 1899, 4) *Sphalerite:* (Eyerman, l. c.).

[188] Formerly Bishop's Mill.

[189] Name from the old Rose Tree Inn on the Providence Road, 1 1/4 miles north of Media.

[190] Aigster (1813, 211) listed "amianthus" from "near Brownsville."

FRANKLIN COUNTY[191]

CHAMBERSBURG.

Travertine: occurs east of Chambersburg (Rogers, 1858, I, 259).

GUILFORD SPRINGS. Lindsay's farm, 3/4 mile northeast of Guilford Springs, just east of the Cumberland Valley, R. R. Stones River (Ordovician) limestone; hydrometamorphic veins of barite; residual masses in the soil.

Barite: white, granular masses (Stose, 1909, 18).

KNEPPER. Stamey's farm, just west of Knepper, Quincy township. Waynesboro formation (Cambrian).

Barite: (Stose, 1909, 18).

WAYNESBORO. Snobarger's farm, 2 miles northeast of Waynesboro, Washington township. Waynesboro formation, and Tomstown limestone (Cambrian); hydrometamorphic veins.

Barite: residual masses in the soil; the source of the masses is exposed in a ledge on the hill side. Barite also occurs locally on farms 2 1/2 miles south, and 3 miles southeast of Waynesboro. (Stose, 1909, 18; Rogers, 1858, I, 258; Frazer, 1880, 262; McCreath, 1879, 369, analyses; Eyerman, 1889, 41).

ROADSIDE. Bonebreake's farm, 1/2 mile southeast of Roadside, Washington township. Elbrook formation; hydrometamorphic veins of barite.

Barite: (Stose, 1909, 18).

LANCASTER STATION.

Fluorite: pale grayish and pink; imperfect cubes and crystalline masses (Genth, 1876, 210).

Barite: white, lamellar cleavage masses (Genth, 1876, 228; Lewis, 1882, 38).

MERCERSBURG.

Limonite: (Cleaveland, 1816, 493).

FULTON COUNTY

FORT LITTLETON. Farms 1/2 mile northeast, and 1 mile north of Fort Littleton. Hydrometamorphic veins of barite; residual masses in the soil.

Barite: bluish-white, granular and lamellar masses (Rogers, 1858, I, 414; Stevenson, 1882, 304; McCreath, 1879, 369; analyses).

HUNTINGDON COUNTY[192]

BROAD TOP MOUNTAIN.

Barite: thin coatings on fossil and calamites that occur in the carboniferous shales (Lewis, 1882, 38).

SIDELING HILL TUNNEL.

Epsomite: small colorless acicular crystals in greenish Pocono shales in the Sideling Hill tunnel of the East Broad Top R. R., in Clay township.

SANDY RIDGE, ORBISONIA. Limonite pit, "Chert Bank," on Sandy Ridge, 2 miles south of Orbisonia, Cromwell township. Oriskany sandstone.

Barite: colorless crystals and masses in limonite (Ashburner, 1878, 271). *Wavellite:* seams of radiating crystals (Ashburner, l. c.).

CHESTER FURNACE. Three-quarters of a mile west of the old Chester Furnace (3 miles west of Orbisonia, Cromwell township).

Goethite: fibrous, containing Co (Boyé, 1847, 238). *Psilomelane:* (Genth, 1875, 53).

WRAY'S HILL TUNNEL. Exposures at Wray's Hill Tunnel, East Broad Top R. R., Todd township, Mauch Chunk red shales, and Pottsville conglomerate.

Calcite: fibrous (Ashburner, 1878, 271). *Quartz:* (Ashburner, l. c.). *Hematite:* specular (Ashburner, l. c.). *Wad:* reniform, coating Pottsville conglomerate (Ashburner, l. c.).

[191] Seybert (1808, 153) listed dodecahedral quartz from Franklin County.

[192] The type locality of celestite, Bellwood, is sometimes given as Huntingdon County; Blair County not having come into existence until 1846.

Eyerman (1889, 238) listed cacoxenite and dufrenite from Dry Hollow. These minerals were inferred to exist from the presence of Mn and P in analyses of goethite (White, 1885, 434).

McCONNELLSTOWN. One mile N. E. of McConnellstown. Walker township.

Galena: near the contact of Lewistown limestone and the overlying Onondago shales (White, 1885, 129).

JUNIATA COUNTY

ROSS FARM. Ross Farm, on the Tuscarora Valley R. R., 5 miles northeast of Blairs Mills, just west of Tuscarora Creek. Abandoned wavellite mine. Oriskany sandstone.

Wavellite: green radiations on sandstone.

LANCASTER COUNTY

BART TOWNSHIP

GAP NICKEL MINES.[193] One and a half miles north of Bart P. O., (Quarryville 3444). Meta-gabbro intrusive in Wissahickon gneiss; magmatic segregations of nickeliferous pyrrhotite at the margins of the mass; pegmatite; a dike of Triassic olivine-diabase outcrops about 1500 feet to the southeast.

Gabbro; primary minerals: *Augite?* (Mombert, 1869, 608). *Biotite?* (Genth, 1875, 69).

Gabbro; hydrothermal metamorphs: *Hornblende:* dark green crystals (Genth, 1875, 69). *Actinolite:* (Dana, 1854, 490). *Amphibole asbestus:* (Genth, 1875, 69). *Chlorite:* (Frazer, 1880, 78).

Gabbro; magmatic deposits; primary: *Pyrrhotite:* nickeliferous, 2.9% Ni (Genth, 1851, 250; Blake, 1851, 339; Boyle, 1852; Rammelsberg, 1864, 361). *Pentlandite?* a small non-magnetic portion of the nickeliferous pyrrhotite was analyzed and gave the composition 3NiS + 2FeS. (Genth, 1875, 13; analysis by Pemberton; Campbell and Knight, 1907, 364). *Chalcopyrite:* (Boyé, 1852, 230; Genth, 1875, 21). *Arsenopyrite?* (Frazer, 1880, 78). *Gold:* traces (Genth, 1875, 5).

Magmatic deposits; hydrothermal metamorphs: *Millerite:* veins of radiating coatings or concentrically radiated semi-globular masses or tufts; pale brass-yellow, sometimes tarnished on the surface to chalcocite. (Genth, 1862, 195; Gramont, 1892, 268, study of spectrum). *Pyrite:* nickeliferous, crystals (Boyé, 1852, 230). *Quartz:* pseudomorphous after calcite (Genth, 1875, 61). *Siderite:* small rhombohedral and prismatic crystals; spherosiderite. (Rand, 1867, 407; Genth, 1875, 160).

Magmatic deposits; hydrometamorphs: *Marcasite?* (Rand, 1867, 407; Beck, 1912, 2, analysis). *Chalcocite:* coating millerite, (Genth, 1862, 195). *Vivianite:* colorless, greenish, or blue; slender prismatic crystals 3 cm. long (Dana, 1868, 779; Genth, 1875, 141).

Magmatic deposits; weathering products: *Copper:* (Genth, 1875, 5). *Scorodite:* (Rand, 1867, 407). *Morenosite:* greenish-white incrustations (Rand, 1867, 407; Rogers, 1858, 11, 709; Genth, 1875, 150). *Melanterite:* stalactitic (Rand, 1867, 407; Rogers, 1858, II, 709; Genth, 1875, 149). *Copiapite:* (Roepper: Mombert, 1869, 609). *Glockerite:* (Genth, 1875, 151, analysis by Roepper). *Chalcanthite:* (Mombert, 1869, 609). *Hisingerite?* black, amorphous (Rand, 1871, 304, analysis).

Pegmatite; primary: *Quartz:* smoky; abundant east of the smelter ruins, 3/4 mile north of the nickel mines (Beck, 1912, 3). *Tourmaline:* black (Beck, 1912, 9).

MT. PLEASANT. Wissahickon gneiss.

Amethyst: purple, with a smoky tint, occurs in fields, 1 mile northwest of Mt.Pleasant; (Beck, 1912, 3).

CAERNARVON TOWNSHIP

BEARTOWN. Limonite pits, 1/2 mile southwest of Beartown, just north of the P. R. R. Cambrian sandstone; residual deposits of goethite and limonite. The mines are abandoned. Other pits occur on Welsh Mountain, 2 miles east, and 3 1/2 miles E. N. E. of Beartown.

Limonite: (Beck, 1912, 5). *Psilomelane:* (Beck, 1912, 5, analysis). *Cacoxenite:* red-

[193] The deposit was discovered in 1732, when attempts were made to work it for copper. In 1853 Genth determined the presence of nickel, and the mine became the largest producer of nickel of its day. The mines were abandoned in 1893.

dish-yellow and golden-yellow tufts of radiating crystals (Dana, 1892, 1069; Goldsmith, 1893, 175; Beck, 1912, 11). *Strengite:* grayish-white translucent globules of a radiating structure, with cacoxenite (Beck, 1912, 11).

Conestoga Township

Rockhill.

Pectolite: hydrothermal metamorph in diabase; (Beck, 1912, 8, analysis). *Prehnite:* light green (Beck, 1912, 9).

Safe Harbor. Limonite pit 1/2 mile southeast of Safe Harbor; and a half mile west of Green Hill School. Three other pits occur along a stream 1/2 mile north of Colemanville. Shenandoah limestone; residual deposits of goethite.

Goethite: geodes (Mombert, 1869, 607). *Aragonite?* tufts of acicular crystals (Mombert, l. c.).

Drumore Township

Quartz: crystals (Dana, 1868, 779). *Chlorite:* (Mombert, 1869, 609).

East Cocalico Township

Adamstown.

Quartz: (Smith, 1885, 413). *Ilmenite:* large crystals in quartz (Smith, 1885, 413, analysis). *Hornblende:* (Smith, 1885, 413). *Heulandite:* in cavities in trap (Smith, 1885, 413, analysis). *Calcite:* (Smith, 1885, 413).

Marietta. Limonite pits northeast of Marietta. Shenandoah limestone; residual deposits of goethite.

Goethite: geodes (J. P. Lesley, Proc. Acad. Nat. Sci. Phila., 8, 229, 1856). *Galena:* in goethite geodes (Lesley, l. c.).

East Hempfield Township

Bamford. Abandoned zinc mines at Bamford, 6 miles northwest of Lancaster. Ordovician limestone; hydrometamorphic veins of galena and sphalerite.

Galena: small lustrous crystals (Dana, 1854, 490). *Sphalerite:* (Dana, 1854, 490). *Tetrahedrite?* minute crystals (Eyerman, 1911, 22). *Tennantite:* steel-gray, massive (Taylor, 1855, 412; Genth, 1875, 24). *Calamine:* minute crystals (Dana, 1854, 490; Genth, 1875, 106). *Dolomite:* (Mombert, 1869, 610). *Smithsonite:* pseudomorphous after dolomite; granular, brownish-gray (Taylor, 1856, 427; Genth, 1875, 161). *Cerussite:* minute crystals on galena (Genth, 1875, 163). *Aurichalcite:* acicular crystals (Taylor, 1855, 412). *Hydrozincite:* white incrustations on smithsonite (Genth, 1875, 166).

Earl Township

New Holland.

Quartz: colorless to smoky crystals, 10 cm. long (Genth, 1875, 56, 58). *Ilmenite:* (Mombert, 1869, 607; Roepper). *Epidote:* (Mombert, 1869, 608).

Eden Township

Quarryville.

Ankerite: reddish-brown rhombohedra, in cut of P. R. R., east of Quarryville (Beck, 1912, 6) *Limonite:* (Beck, 1912, 5). *Orthoclase:* (Genth, 1875, 17). *Pyrrhotite:* plates with orthoclase (Genth, 1875, 17).

Ephrata Township

Glenwood Station.[194] Old copper mine, a short distance north of Glenwood Station, on the Conestoga Electric R. R. Triassic shales; hydrometamorphic concentrations.

Chalcocite: small scattered deposits in Triassic shales (Beck, 1912, 1). *Melaconite:* (Beck, 1912, 3). *Cuprite:* small deep red masses (Beck, 1912, 3). *Pyrolusite:* (Beck, 1912, 4). *Malachite:* coatings (Beck, 1912, 7). *Azurite:* coatings (Beck, 1912, 7).

[194] "Reamstown" of Beck (1912). This town lies 3 miles to the northeast.

EPHRATA. Railroad cut 1 mile north of Ephrata, just south of Mohlers Meeting House. Cambro-ordovician limestone.

Fluorite: deep purple cubes (Beck, 1912, 2). *Chondrodite?* bright orange-yellow to brownish-yellow, nearly transparent grains with fluorite. (Beck, 1912, 9).

FULTON TOWNSHIP

LINE PIT: LOW'S MINE.[195] On the Pennsylvania-Maryland Line, about two miles south of Texas, and about one northwest of Rock Springs, Md. (Havre de Grace 1632). Other mines in the immediate vicinity are the Red Pit on the road one half mile northeast of the Line Pit (Havre de Grace 2178); Jenkins mine, on Rock Springs Run, one mile north of Rock Springs, Md., and just southwest of Rock Springs Church (Penna.) (Havre de Grace 2184); Tyson Reynold's mine, two miles northeast of Rock Springs, Md., just south of the fork to Wrightsdale (Havre de Grace 2247); and Brown's mine on Soapstone Hill, one and a quarter miles northeast of Texas (Quarryville 8764). Meta-peridotite; magmatic deposits of chromite.

Peridotite; primary: *Chromite:* black, lustrous masses (Dana, 1850, 655).

Peridotite; hydrothermal metamorphs: *Serpentine; williamsite, picrolite:* green, bluish-green, grayish, laminated masses (Shepard, 1848, 249; Dana, 1850, 692, 655; Hermann, 1851, 31; Smith and Brush, 1853, 213; Genth, 1875, 116; 1862, 203; analyses). *Talc:* greenish-white foliated masses (Dana, 1850, 655; Genth, 1875, 112). *Penninite; kammererite:* dark green or violet colored crystals, pink or reddish, scaly or fibrous masses (Garrett, 1853, 332; Rand, 1867, 407).

Meta-peridotite; hydrometamorphs: *Brucite:* pearly white crystals, and laminated masses (Dana, 1854, 490; 1868, 178; Brush, 1861, 94). *Hydromagnesite:* acicular crystals and radiated masses, with brucite (Smith and Brush, 1853, 214; Weinschenk, 1897, 568). *Magnesite:* white, massive (Dana, 1850, 655; Genth, 1875, 157).

Magmatic deposits; weathering products: *Zaratite:* emerald-green vitreous coatings (Dana, 1850, 655). *Genthite:* apple-green, mammillary coatings (Genth, 1875, 116).

TEXAS (LYLES P. O.)[196] Boice farm, one and a half miles W. S. W. of Texas, or one and a quarter miles north of Pleasant Grove, just east of Pleasant Grove Road. (Havre de Grace 1315.3) Meta-peridotite and Wissahickon mica schists.

Pyrite: cubes, cubo-octahedra, and pyritohedra; crystals loose in the soil, or embedded in soft chlorite schists. (Dana, 1850, 655).

Old magnesite quarries, one quarter mile southeast of the above locality; and one and a half miles southwest of Texas (Havre de Grace 1316.8). Meta-peridotite.

Serpentine; marmolite: (Dana, 1850, 655). *Magnesite:* (Carpenter, 1828, 10; Dana, 1850, 655; Frazer, 1880, 97). *Dolomite:* mammillary masses in serpentine (Garrett, 1853, 334).

Exposures in the vicinity of Texas. *Enstatite; bronzite:* large masses occur one half mile west of Texas. (Garret, 1853, 333, analysis). *Anthophyllite:* (Dana, 1850, 655). *Ilmenite:* (Eyerman, 1889, 9).

PLEASANT GROVE. Exposures in woods, at base of hill, south of Conowingo Creek, about one mile southeast of Pleasant Grove. Granite gneiss, containing xenoliths of talc and actinolite.

Actinolite: green crystals in talc (Carpenter, 1828, 10). *Talc:* (Carpenter, 1828, 10).

ROCK SPRINGS RUN. Exposures in vicinity of, and bed and banks of a small branch emptying into Rock Springs Run, about one and a quarter miles north of Rock Springs, Md. Meta-peridotite.

Serpentine; chrysolite: (Carpenter, 1828, 10). *Magnetite:* octahedra in chlorite (Carpenter, l. c.). *Ilmenite:* (Dana, 1850, 655). *Chalcedony; carnelian; jasper; moss-agate:* (Carpenter and Spackman, 1826, 224; Dana, 1850, 655).

[195] This locality and Wood's mine, described below, have been together known as "Texas, Pa." The first reference to it was made by Carpenter, 1828, 10, who called it "Joel Jackson's farm."

[196] The granular albite described by Silliman, Jr., 1849, 389, from the vicinity of the chrome mines, undoubtedly occurred in Maryland, one half mile south of the Line Pit, and one half mile west of Rock Springs, Md., on the banks of Sweigart's Run.

Dana (1850, 655) listed "green tourmaline in talc" from Texas, but the exact locality is unknown. A specimen is in the possession of Mr. Frank J. Keeley; the matrix of the tourmaline seems to be sericite, and not talc.

Abandoned iron mine, one mile N. N. W. of Rock Springs, Md. Magmatic deposit of magnetite; meta-peridotite.

Magnetite: large masses (Genth, 1875, 39).

LANCASTER

Pyrite: brilliant cubic crystals are abundant in the limestone underlying the city; sometimes occurs altered to limonite (Dana, 1868, 779; Genth, 1875, 19). *Wad:* coating on sandstone in a sand pit in the eastern part of Lancaster (Beck, 1912, 6). *Calcite:* colorless rhombohedral and scalenohedral crystals have been found near the Lancaster Gas Works; exposures south of Lancaster, near the third lock of the old Conestoga canal; and on the farm of George Kendig, about 300 yards from the south end of the bridge over the Conestoga, at Wabank (Mombert, 1869, 609; Beck, 1912, 6). Travertine occurs in Heidig's quarry on the Groffstown road, just beyond the end of East Chestnut Street, Lancaster; tufa occurs in considerable masses 200 yards south of Gables Park on the Conestoga, south of Lancaster (Mombert, 1869, 610; Beck, 1912, 6). *Aragonite:* in caves south of Lancaster (Beck, 1912, 7). *Fluorite:* purple cubes occur in Heidig's quarry (Beck, 1912, 2).

LITTLE BRITAIN TOWNSHIP

WOOD'S CHROME MINE.[197] In the ox-bow of Octoraro Creek, 3/4 mile southwest of Lee's Mill, and about 5 miles W. N. W. of Sylmar Station, P. B. & W. R. R. Meta-peridotite; magmatic deposits of chromite. The mine was worked to a depth of 800 feet. Placer deposits were developed along the Octoraro Creek.

Peridotite; primary: *Bronzite:* (Dana, 1868, 779). *Olivine?* yellowish-green, vitreous (Genth, 1866, 120). *Chromite:* magmatic deposits; black massive (Dana, 1850, 655); Garrett, 1852, 46, analysis).

Peridotite; hydrothermal metamorphs: *Serpentine; williamsite, marmolite, picrolite:* (Rammelsberg, 1847, 107; 1860, 526; Silliman, 1849, 134; Dana, 1850, 655, 692; Genth, 1862, 203; 1875, 116; Rand, 1867, 407; analyses). *Clinochlore; ripidolite:* pale green twinned crystals, associated with kammererite (Shepard, 1849, 134; Cooke, 1867, 201; Genth, 1875, 131; Kokscharov, 1888, 26; Tschermak, 1890, 99; I, 1891, 182, 238, 249). *Penninite; kammererite:* dark green or violet crystals, more frequently pink or reddish, scaly fibrous or granular aggregates (Dana, 1850, 655; Hermann, 1851, 21; Genth, 1853, 121; Blake, 1852, 117; Smith and Brush, 1853, 47; analyses by: Hermann, 1851, 21; Garrett, 1853, 332; Dieffenbach, 1855, 534; Pearse, 1864, 222; Genth, 1875, 130; crystallography and optical properties: Cooke, 1867, 201; Dana 1868, 495; Pirsson, 1891, 408; Tschermak, I, 1891, 238; 249; Descloizeaux, 1868). *Uvarovite:* minute transparent crystals, of very rare occurrence in clinochlore (Shepard, 1866, 216). *Vesuvianite:* greenish, yellowish and brownish, columnar crystalline aggregates (Genth, 1875, 178). *Millerite:* small grains and nodules in kammererite (Blake, 1852, 117).

Meta-peridotite; hydrometamorphs: *Brucite:* large tabular crystals, groups of crystals, rosettes or radiating masses; more frequently in broad foliated silver white, or rose-colored, broad foliated masses (Smith and Brush, 1853, 214; Hartmann, 1855, 107; Genth, 1875, 51; analyses by Smith and Brush, l. c.; Hermann, 1861, 368; Clarke and Schneider, 1890, 456; crystallography: Rose, 1860, 178; Brush, 1861, 94; Hermann, 1861, 368; Hessenberg, 1862, 40; 1869, 45; Dana, 1868, 176; Gratacap, 1912, 110). *Hydromagnesite:* druses of acicular crystals; radiated, crystallized seams, with brucite (Smith and Brush, 1853, 214; Dana, 1854, 84; 1892, 305; Weinschenk, 1897, 570; a mixture of hydromagnesite and brucite was described by Silliman, 1850, 216, under the name of lancasterite). *Calcite:* rhombohedra on chromite (Dana, 1850, 655; Genth, 1875, 154). *Chalcocite:* rarely with chromite (Genth, 1875, 16).

Meta-peridotite; weathering products: *Quartz:* druses of minute crystals, often ferruginous (Genth, 1875, 57). *Chalcedony; hornstone; jasper:* (Genth, 1875, 60, 69). *Aragonite:* radiating crystals, druses (Rand, 1867, 407). *Dolomite:* mammillary incrustations of minute crystals, often colored green by small admixtures of zaratite (Dana, 1850, 655; Garrett, 1853, 334; Genth, 1875, 156; Shepard, 1848, 250; Hermann, 1849, 13, described a mixture of dolomite and

[197] Commonly known with Low's mine, as "Texas, Pa." The mine was opened in 1828 by Isaac Tyson. Corundum and albite have been reported from the vicinity of the mines (Genth, 1875, 32; Silliman, 1849, 389; analysis).

zaratite under the name pennite). *Magnesite:* (Dana, 1850, 655). *Zaratite:* emerald-green, vitreous coatings on chromite (Silliman, 1847, 407). *Genthite:* green, mammillary coatings on chromite (Genth, 1851, 487; Dana, Am. J. Sci., 44, 1867, 256). *Vermiculite:* (Shepard, 1866, 216). *Deweylite:* yellowish, greenish, reddish or brownish, resinous amorphous coatings (Genth, 1852, 122; Dana, 1854, 286; Genth, 1875, 117; Beck, 1912, 10; analyses).

Chrome sand placers: *Chromite:* (Dana, 1850, 655; Garrett, 1852, 46, analysis). *Ilmenite:* (Dana, 1868, 779). *Hematite?* (Dana, 1868, 779; Genth, 1875, 34).

CARTER'S CHROME MINE. About 150 yards east of Wood's Mine.

Serpentine: massive, red (Rand, 1867, 406). *Deweylite:* (Rand, l. c.). *Dolomite:* (Rand, l. c.). *Magnesite:* (Genth, 1875, 167). *Hydromagnesite:* (Rand, l. c.). *Zaratite:* (Rand, l. c.). *Brookite:* iron black prismatic crystals 2 cm. long (Genth, 1875, 45). *Magnetite:* minute octahedra in serpentine (Beck, 1912, 4).

WHITE ROCK. On the Oxford, Lancaster and Southern Ry., 4 1/2 miles southeast of Quarryville.

Talc: (Beck, 1912, 10). *Chrysolite asbestus:* olive-green to greenish-white (Beck, 1912, 10). *Magnetite:* (Beck, l. c.).

MANHEIM TOWNSHIP

EAST PETERSBURG.

Sphalerite: occurs in a dolomitic limestone, along the railroad, 1/4 mile south of East Petersburg (Beck, 1912, 1).

ROSSMERE.

Quartz: crystals measuring up to 6.5 dcm. have been found in the limestone quarries north of Lancaster (Beck, 1912, 2).

FRUITVILLE. Farm of Jacob Hess, adjoining the Fruitville Schoolhouse, immediately south of the Neffsville Ridge. Octoraro schist.

Limonite: pseudomorphous after pyrite; nearly perfect pyritohedra, often twinned; combinations of cube, octahedron and pyritohedron, up to 5 cm. Brownish cubes are common in the soil, on most of the farms north of Lancaster. (Beck, 1912, 5).

MANOR TOWNSHIP

MILLERSVILLE. One half mile east of Millersville, on the road leading east from the York Furnace Trolley station, and about 500 yards from Conestoga Creek.

Fluorite: grayish-white masses, in Cambro-ordovician limestone (Beck, 1912, 2).

MARTIC TOWNSHIP

MARTICSVILLE.

Magnetite: small black grains disseminated through milky quartz, at an old mine on Pequa Creek, a short distance from Marticsville on the York Furnace Road (Beck, 1912, 4).

RAWLINSVILLE.

Cyanite: blue to gray, bladed masses in Wissahickon gneiss (Beck, 1912, 9).

CULLY STATION.[198]

Kalinite: efflorescence on Wissahickon gneiss.

PARADISE TOWNSHIP

KINZER.

Quartz: colorless crystals in the soil (Genth, 1875, 56). *Rutile:* acicular crystals in quartz (Genth, 1875, 44).

PEQUA TOWNSHIP[199]

BAUMGARDNER.

Ilmenite: occurs on farm of Joseph Charles, 1 1/2 miles west of Baumgardner's Station, P. R. R. (Beck, 1912, 3).

[198] The locality was formerly known as Cully Falls, which were one and a half miles southeast of McCall's Ferry.

[199] Cleaveland (1822, 151) listed calcite, in radiating crystals, 6 miles south of Lancaster. Mombert (1869, 609) listed margarite as occurring near the Pequa mine.

HERRVILLE.

Tourmaline: black, granular; in the vicinity of a cave known as Bosler's Hole, on a hill just beyond the railroad bridge over Pequa Creek, southeast of Herrville. (Mombert, 1869, 608; Beck, 1912, 9).

PEQUA MINES.[200] On Pequa Creek, 1 1/2 miles east of Conestoga; and 1/2 mile east of Good's Crossing on the York Furnace Trolley Line.

Quartz: colorless crystals (Genth, 1875, 56). *Adularia?* (Cleaveland, 1816, 268). *Chloritoid, phyllite:* small greenish-black scales in a siliceous limestone (Genth, 1875, 135). *Rutile:* in limestone (Genth, 1875, 44). *Siderite:* (Cleaveland, 1816, 514). *Galena:* argentiferous; with a distinct octahedral and cubic cleavage (Cleaveland, 1816, 514; Dana, 1854, 490; Torrey, Cooke, and Brush, 1863, 126–129). *Cerussite:* (Cleaveland, 1816, 517). *Calamine:* minute crystals (Cleaveland, 1816, 543; Genth, 1875, 106). *Anglesite:* (Genth, 1875, 147). *Vauquelinite:* green, minute crystals with acute terminations, often in radiated aggregations on quartz and galena (Taylor, 1858, 175). *Wulfenite:* grayish, yellowish-white; tetragonal plates (Genth, 1875, 145).

PROVIDENCE TOWNSHIP

Graphite: (Beck, 1912, 1). *Turgite:* (Beck, 1912, 5, analysis).

SADSBURY TOWNSHIP

GAP HILLS.

Quartz: smoky (Mombert, 1869, 608: Kevinski).

SALISBURY TOWNSHIP

Galena: in quartz (Mombert, 1869, 607).

STRASBURG TOWNSHIP

Amethyst: southeast of Strasburg (Beck, 1912, 3).

WEST COCALICO TOWNSHIP

COCALICO.

Muscovite: one mile east of Cocalico P.O. (Beck, 1912, 9).

REINHOLD'S STATION.

Azurite: small deep blue seams in Triassic shales (Genth, 1875, 229).

SHOENECK

Limonite: (Mombert, 1869, 608). *Resin?* in limonite (Mombert, 1869, 610).

WEST EARL TOWNSHIP

Manganocalcite: black crystalline near Cocalico Creek, (Beck, 1912, 6, analysis).

WEST HEMPFIELD TOWNSHIP

CHESTNUT HILL. Limonite pits 1 mile northwest of Chestnut Hill, in valley of a small stream southwest of Silver Spring. Other pits are located one mile southeast of Newtown, just south of Big Chickies Creek. Chickies quartzite; residual deposits of goethite and limonite.

Goethite: fibrous, reniform masses; geodes (Mombert, 1869, 607; Genth, 1875, 48). *Lepidocrocite:* druses of minute crystals (Mombert, l. c.; Genth, l. c.). *Limonite:* brown, ochery (Mombert, 1869, 607). *Kaolinite:* (Genth, 1875, 119, analysis). *Wavellite:* small globular radiating concretions (Mombert, 1869, 609: Haldeman; Genth, 1875, 143). *Cacoxenite:* (Mombert, 1869, 609: Haldeman).

LEBANON COUNTY

CORNWALL.[201] Cornwall iron ore banks, on the south side of the Lebanon Valley, 5 miles south of Lebanon. Cambrian sandstone; Cambro-ordovician limestones and limy shales;

[200] The mines were worked for silver prior to the Revolution.

[201] The deposits are described by Spencer, 1908, 17–28.

Eyerman (1889, 22, 35) reported olivine, lepidolite, and neolite; but the occurrence of these minerals needs confirmation.

Triassic red sandstones and shales; intrusive diabase; tactite; hydrothermal deposits of magnetite and pyrite replacing the limy shales.

The ore body is one of the largest ever mined; in addition to iron, copper and gold are recovered as by-products, but large quantities of cobalt (present in the pyrite) are not recovered, but lost in the slag. Sandstone and limestone are quarried on the south side of the pit.

Calcareous sediments; hydrothermal (contact) metamorphs: *Mussite:* minute white crystals (Genth, 1875, 65). *Asbestus:* (Eyerman, 1889, 17). *Byssolite:* (Genth, 1875, 68). *Andradite:* brownish-red and brown-olive dodecahedral and trapezohedral crystals, sometimes studded with minute pyrite crystals; up to 2.5 cm. in diameter (Eyerman, 1889, 35; Gordon, Am. Min., 2, 1918, 164). *Vesuvianite?* imperfect striated crystals (Genth, 1875, 78). *Serpentine:* light green, massive (Dana, 1868, 779; Eyerman, 1911, 16, analysis). *Ripidolite:* (Eyerman 1889, 35).

Hydrothermal deposits; primary: *Hematite:* foliated, micaceous (Genth, 1875, 34). *Magnetite:* foliated, micaceous masses; octahedral and dodecahedral crystals; lodestone (Seybert, 1821, 142; Smith, 1855, 188; Genth, 1875, 39). *Pyrite:* cubo-octahedra, modified by numerous trigonal trisoctahedral faces; cupriferous and cobaltiferous varieties occur (analysis by Blake showed 2% Co), (Seybert, 1821, 142; Dana, 1850, 656; 1854, 55; 1868, 63; Eyerman, 1889, 5; Travis, 1906, 131; analyses). *Chalcopyrite:* large tetrahedral crystals; rarely in small prismatic crystals, commonly twinned; sometimes with a tarnish and coated with malachite (Dana, 1868, 779; Genth, 1875, 23). *Sphalerite:* small greenish crystals, usually twinned, often distorted (Genth, 1882, 400, analysis). *Prehnite:* colorless, white, yellowish or greenish, fan-shaped aggregates of small tabular crystals, lining cavities in magnetite, with sphalerite (Genth, 1882, 401, analysis). *Analcite?* in cavities in magnetite (Eyerman, 1889, 35). *Fluorite:* (Dana, 1868, 779). *Calcite:* rhombohedral and scalenohedral crystals, sometimes colored pink by cobalt (Genth, 1875, 154). *Quartz:* drusy; sometimes pseudomorphous after calcite (Dana 1868, 779; Genth, 1875, 61).

Hydrothermal deposits; weathering products:[202] *Chalcedony; jasper:* pale brown or greenish, mammillary or botryoidal (Genth, 1875, 59; Smith, 1855, 188). *Opal:* grayish, greenish, yellowish-white, vitreous (Genth, 1875, 61). *Allophane:* white and blue mammillary and stalactitic masses (Dana, 1868, 779; Genth, 1875, 107). *Chloropal?* greenish masses (Eyerman, 1889, 35). *Aragonite:* radiating acicular crystals (Eyerman, 1889, 44). *Rhodochrosite:* globular concretions in cobaltiferous wad. (Genth, 1875, 161). *Gypsum:* slender crystals up to 5 cm. in length, often with arborescent copper, on magnetite (Genth, 1875, 148). *Copper:* small red cubic crystals; distorted; usually in arborescent or reticulated sheets covered with minute crystals (Dana, 1854, 490; Genth, 1875, 4). *Chalcocite:* (Eyerman, 1889, 5). *Covellite:* thin coatings on magnetite (Genth, 1875, 23). *Cuprite:* granular masses, rarely in cubic or dodecahedral crystals; sometimes in fine crimson-red capillary crystals (chalcotrichite); or as thin coatings on copper giving it a dull purplish appearance (Seybert, 1821, 142; Dana, 1854, 490; Genth, 1875, 30). *Hydrocuprite:* amorphous orange-yellow to red, thin, somewhat rag-like coatings on magnetite (Genth, 1875, 46). *Malachite:* fibrous masses (Seybert, 1821, 142; Genth, 1875, 167). *Azurite:* dark azure-blue crystals, measuring 5 mm., usually in crystalline crusts (Dana, 1854, 490; Genth, 1875, 168). *Chrysocolla:* blue or green; massive, botryoidal or stalactitic masses (Smith, 1855, 188; Genth, 1875, 105). *Brochantite:* dark emerald-green or blackish-green acicular crystals and crusts on magnetite (Genth, 1875, 151). *Langite?* small bluish-green crystals (Genth, 1875, 151). *Bieberite:* flesh colored incrustations on magnetite (Genth, 1875, 149). *Botryogen:* deep red microscopic crystalline aggregates with covellite and pyrite on magnetite (Genth, 1875, 150). *Hausmannite:* (Dana, 1868, 162). *Crednerite?* cobaltiferous: a soft, black mineral, shining when cut, rarely imbedded in chrysocolla was found to contain MnO, CoO, and CuO in the proportions: 70 : 40 : 44 (Genth, 1875, 54,). *Wad:* cobaltiferous (Genth, 1875, 161)

LEHIGH COUNTY[203]

LOWER MACUNGIE TOWNSHIP[204]

ALBURTIS. Limonite pits in the vicinity of Alburtis. Cambrian quartztite; Cambro-ordovician limestone; residual deposits of limonite and goethite.

[202] Including some hydrometamorphs.

[203] Marcasite was said to occur in large masses in many of the limonite pits; epsomite occurred as efflorescences on dolomite (Genth, 1875, 22, 149).

[204] Pyrite has been reported from Macungie (Schrader, Stone, and Sanford, 1917, 265).

Siderite: (Eyerman, 1889, 43, analysis). *Wad:* ocherous, cobaltiferous (Roepper; Genth, 1875, 54).

LOWER MILFORD TOWNSHIP

HOSENSACK STATION. Farm of Jacob Schell, south of Hosensack Station. Triassic shales; intrusive diabase.

Pectolite: compact grayish masses of acicular crystals (Smith, 1885, 411, analysis). *Stilbite:* large radiating aggregates of crystals (Smith, 1883, 277, analysis).

NEAR HOSENSACK STATION.

Pyroxene: green crystals (Smith, 1885, 412). *Titanite:* dark brown crystals (Smith, 1885, 412, analysis). *Andradite:* olive-green dodecahedral crystals, with hematite (Smith, 1883, 276, analysis). *Hematite:* specular (Smith, 1883, 276).

LOWER SAUCON TOWNSHIP

SOUTH MOUNTAIN.

Epidote: yellowish-green crystals in gneiss (Genth, 1875, 79). *Chlorite:* (Genth, 1875,133). *Chalcocite:* small crystals in Triassic sandstones in the southwestern corner of the township (Genth, 1875, 16). *Malachite:* stains on Triassic rocks (Genth, 1875, 167).

NORTH WHITEHALL TOWNSHIP

OMROD. Limestone quarries along the Ironton Branch, Lehigh Valley R. R., southwest of Omrod Station.

Quartz: crystals (Smith, 1883, 272). *Fluorite:* green, purple, and pink (Genth, 1875, 29; Smith, 1883, 272, analysis).

IRONTON. Abandoned limonite pit north of Ironton. Filled with water. Cambro-ordovician limestone; residual deposits of goethite and limonite.

Copper: minute distorted crystals (Genth, 1875, 5). *Psilomelane:* stalactitic, botryoidal, and reniform masses (Genth, 1875, 217, analysis). *Pyrolusite:* mixed with psilomelane (Genth, 1875, 217). *Allophane:* white, mammillary coatings (Prime, 1878, 43; Smith, 1883, 272, analysis).

SALISBURY TOWNSHIP

MOUNTAINVILLE.

Tourmaline: black, on Lehigh Mountain (Smith, 1883, 275, analysis). *Chloropal:* soft yellowish-green, occurs at prospect pits on Lehigh Mountain. *Pyrolusite:* crystals in goethite geodes in limonite pits along the south side of Lehigh Mountain (Smith, 1883, 277, analysis).

UPPER MACUNGIE TOWNSHIP

BREINIGSVILLE. *Pyrite:* in limonite pits (Eyerman, 1889, 5).

UPPER MILFORD TOWNSHIP

EMAUS.

Fluorite: deep purple octahedra in a granitic rock on Lehigh Mountain (Smith, 1883, 273: Sadtler).

VERA CRUZ. Quarry in granite gneiss, along P. & R. R. R. 1/2 mile south of Vera Cruz Station. Granite gneiss and pegmatite.

Molybdenite: (Schrader, Stone, and Sanford, 1917, 264). *Uraninite:* traces (Edgar T. Wherry).

SHIMERSVILLE.[205] Abandoned iron mine, 1 1/4 miles north of Shimersville. Precambrian gneisses.

Tourmaline: black (Smith, 1883, 275).

Corundum mine, 3/4 of a mile north of Shimersville. Abandoned. Pegmatite.

Corundum: large rough barrel-shaped crystals, sometimes asteriated; crystals measure up to 15 cm. in length, and 8 cm. in diameter (Smith and Thomas, 1882, 230; Smith, 1883, 275, analysis). *Spinel:* minute black crystals in corundum (Genth, 1882, 382, analysis). *Ilmenite:* (Genth, 1882, 382). *Tourmaline:* large black crystals (Smith, 1883, 275).

Abandoned magnetite mine, south of Shimersville.

[205] Genth (1875, 65) reported salite, and Eyerman (1889, 5) stalactitic masses of pyrite, from the vicinity of Shimersville.

Almandite: imperfect dodecahedra, with magnetite (Smith, 1883, 276, analysis).

MACUNGIE. Farm of Jacob Stine, 2 miles south of Macungie. Hardyston quartzite, Precambrian gneisses.

Graphite: (Smith, 1883, 273). *Pyrite:* minute crystals (Smith, l. c.). *Zircon:* minute brown crystals (Smith, 1883, 273). *Wavellite:* colorless radiating crystals, 1/4 mile west of the zircon locality, on the same farm (Smith and Thomas, 1882, 230; Smith, 1883, 273). *Pyrolusite:* with limonite (Eyerman, 1889, 10).

UPPER SAUCON TOWNSHIP

EMAUS. Fields 2 miles east of Emaus. Boulders of Hardyston quartzite.

Quartz: jasperized or ferruginous, minute crystals.

FRIEDENSVILLE.[206] Zinc mines in the Saucon Valley, 1/2 mile N. N. W. of Friedensville. Cambro-ordovician limestone; hydrometamorphic concentrations of sphalerite.

Quartz: crystals; fetid (Dana, 1850, 656; Genth, 1875, 57, 59). *Dolomite:* small rhombohedra (Eyerman, 1889, 43). *Asbestus; mountain-leather:* (Genth, 1875, 69). *Sphalerite:* grayish and yellowish, fine grained masses; rarely in minute yellow crystals (Genth, 1875, 15, analysis; Noelting, 1887, 116). *Greenockite:* yellow, orange-yellow, or greenish-yellow coatings on sphalerite (Dana, 1868, 779; Genth, 1875, 18; Lacroix, 1884, 465). *Pyrite:* small cubo-octahedra, sometimes altered to limonite (Genth, 1875, 20).

Weathering products. *Aragonite;* zinciferous: white and yellowish-white radiating crystals (Genth, 1875, 162, analysis by Roepper). *Smithsonite:* granular masses; small scalenohedra (Boyé, 1853, 329; Smith, 1855, 188; Genth, 1875, 161). *Hydrozincite:* porcelain-like or earthy masses; mammillary coatings (Dana, 1868, 779; Genth, 1875, 166). *Malachite:* (Dana, 1850, 656). *Calamine:* small crystals in druses and radiating groups; also granular and massive (Dana, 1850, 656; Genth, 1875, 106; Eyerman, 1889, 29, analysis; Groth, 1878, 220). *Allophane:* white botryoidal and stalactitic masses (Dana, 1868, 779; Genth, 1875, 107). *Kaolinite, sauconite:* yellow, buff, brown, gray and white; amorphous masses (Dana, 1868, 409; Genth, 1875, 120; Roepper; analyses). *Halloysite:* compact, porcelain-like masses (Genth, 1875, 122). *Goslarite:* efflorescences of minute white needle-like crystals (Rand, 1867; Genth, 1875, 149). *Pyrolusite:* (Dana, 1850, 656). *Wad:* (Dana, 1850, 656).

Erratic boulder: *Lanthanite:* a mass of closely aggregated thin tabular crystals, delicate pink in color, was found in an ochery soil over a bed of calamine. The occurrence probably represents a weathered erratic boulder of allanite. (Blake, 1853, 228; 1858, 245; Smith, 1854, 378; analyses).

LIMEPORT.

Crocidolite: occurs as bluish crystalline fibrous coatings in boulders of gneiss, 1 mile east of Limeport, and along the roads, and adjacent fields between Limeport and Cooperstown (Genth, 1875, 70; Roepper). *Grossularite:* white and brownish-white dodecahedral crystals near a trap dike (Genth, 1875, 72).

WHITEHALL TOWNSHIP

CATASAUQUA.

Calcite: in hollow quills (Genth, 1875, 154).

LACKAWANNA COUNTY

SCRANTON.

Siderite: grayish-brown crystals in argillaceous siderite in carboniferous shales (Genth, 1875, 160). *Sphalerite:* with siderite (Eyerman, 1889, 4). *Millerite?* yellow acicular crystals with quartz, in siderite (Genth, 1875, 16). *Phytocollite:* a hydrocarbon (Dana, 1892, 1069).

LUZERNE COUNTY[207]

BEAR CREEK.

Pyrolusite: blue to purplish-black, on Broad Mountain, at the head waters of Bear Creek (Cleaveland, 1816, 548; Cist, 1821, 38). *Psilomelane; wad:* (Cleaveland, l. c.; Cist, l. c.).

[206] Eyerman (1889, 3) lists sulfur in large masses, but the material reported was undoubtedly a smelter product.

[207] Dana (1892, 78) lists massive bornite from "Mahoopeny, near Wilkesbarre." Eyerman (1911, 21) considers this an error.

Quartz: limpid crystals; on Broad Mountain (Porter, 1824, 233).

DRIFTON.

Pyrophyllite: white, yellowish-white, cryptocrystalline; occurs in the Buck Mountain seam on the Tomhicken basin; at the Cross Creek Colliery (Genth, 1882, 402; analysis).

GOWEN.

Pyrophyllite: white and yellowish-white, cryptocrystalline; in the Buck Mountain seam (Genth, 1882, 402).

LYCOMING COUNTY[208]

ROARING BRANCH OF LYCOMING CREEK.

Quartz: drusy, geodic, in the Upper Catskill formation (Meyer, 1893, 194). *Calcite:* (Meyer, l. c.). *Dolomite:* (Meyer, l. c.). *Siderite:* (Meyer, l. c.). *Fluorite?* (Meyer, l. c.). *Galena:* (Meyer, l. c.). *Sphalerite:* (Meyer, l. c.). *Pyrite:* (Meyer, l. c.). *Chalcocite:* (Meyer, l. c.). *Chalcopyrite:* (Meyer, l. c.). *Millerite?* (Meyer, l. c.).

MUNCY.

Bornite: of local occurrence in the Catskill sandstone (Genth, 1875, 13). *Chalcocite:* (Genth, 1875, 16).

BALD EAGLE VALLEY.

Galena: in limestone (Cleaveland, 1816, 514).

MIFFLIN COUNTY

OPPOSITE MT. UNION.

Fluorite: in Lewistown limestone (Lewis, 1876, 11). *Calcite; ferrocalcite:* (Lewis, l. c.). *Aragonite:* (Lewis, l. c.). *Strontianite:* acicular crystals (Lewis, l. c.).

MONROE COUNTY

BROAD MOUNTAIN.

Quartz: limpid crystals (Porter, 1824, 233). *Pyrolusite:* blue to purplish-black, occurs at the head waters of Tobyhannah Creek, and the Lehigh River (Cleaveland, 1816, 548; Cist, 1821, 38). *Psilomelane; wad:* (Cleaveland, l. c.; Cist, l. c.).

CRYSTAL HILL. Just west of Stormsville, 7 miles west of Delaware Water Gap; Hamilton township.

Quartz: crystals (Goodwin; Mineral Collector, 10, 5, 1903).

DELAWARE WATER GAP. Cut on the N. Y., Susquehanna, and Western R. R., on Broadhead Creek, North Water Gap; Smithfield township.

Quartz: crystals measuring up to 15 × 7 cm. (Goodwin, Mineral Collector, 10, 5, 1903).

MONTGOMERY COUNTY

ABINGTON TOWNSHIP[209]

HARPERS STATION. Cut on the P. & R. Ry. north of Harpers Station. Wissahickon gneiss and pegmatite.

Tourmaline: crystals (Benge and Wherry, XIII, 1906, 60). *Halotrichite:* weathering product (Benge and Wherry, l. c.).

EDGE HILL.

Hematite (erroneously called ilmenite): black, lamellar masses (Genth, 1882, 400; 1875, 34, analysis). *Rutile:* minute orange or brownish-yellow grains (Genth, 1882, 399). *Zircon:* yellowish or brownish, more or less rounded, crystals (Genth, 1882, 400). *Tourmaline:* dark brown (Genth, 1882, 400).

DROWN'S FARM, near Weldon, on Edge Hill. Chickies quartzite.

Hematite: (Rand, 1892, 184). *Rutile:* red, slender crystals on hemantite, (Rand, l. c.)

HAMMIT'S QUARRY, just west of Ardsley Station, P. & R. Ry. Chickies quartzite.

[208] (Rogers, 1858, I, 501) listed limpid quartz crystals from the Nittany Valley. The Bald Eagle iron meteorite, preserved at Bucknell College, Lewisburg, was found on the east side of Bald Eagle Mountain, 7 miles south of Williamsport (Owens, 1892, 423).

[209] Blue quartz was listed by Seybert (1808, 156).

Hematite: lamellar masses; *martite;* (Eyerman, 1889, 8; Benge and Wherry, XIII, 1906, 60).

SMITH'S QUARRY, east of bridge over P. & R. Ry. at Edge Hill. Chickies quartzite.

Quartz: crystals (Benge and Wherry, XIII, 1906, 60). *Hematite* and *martite:* (Dana, 1868, 779; Rand, 1892, 184). *Rutile:* (Benge and Wherry, l. c.). *Tourmaline:* black (Benge and Wherry, l. c.). *Staurolite?* (Benge and Wherry, l. c.). *Torbernite?* (Benge and Wherry, l. c.).

CHELTENHAM TOWNSHIP[210]

OGONTZ. Quarry at Old York Road and Tacony Creek. Wissahickon gneiss and metagabbro. (Germantown 8224).

Quartz: (Benge and Wherry, XIII, 1906, 60). *Hornblende:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.).

WYNCOTE. Weber's quarry, just west of Jenkintown Station, P. & R. Ry. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XIII, 1906, 61). *Almandite:* brilliant trapezohedra up to 3 cm. (Benge and Wherry, l. c.).

HEACOCK'S QUARRY, 1/4 mile west of Jenkintown Station. Wissahickon gneiss and pegmatite. Abandoned.

Albite: (Rand, 1892, 182). *Muscovite:* (Benge and Wherry, XIII, 1906, 61). *Torbernite:* minute green plates (Rand, l. c.).

WILSON'S QUARRY, at west end of bridge over P. & R. Ry. at Edge Hill. Chickies quartzite. The same minerals were found in Rhoad's quarry, 1/8 mile further west.

Quartz: blue (Benge and Wherry, XIII, 1906, 61). *Hematite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.).

DOUGLASS TOWNSHIP

CONGO. Yost's farm, 1/2 mile west of Congo, about 4 miles east of Boyertown. Triassic shales.

Quartz: (Benge and Wherry, XIII, 1906, 41). *Hornblende:* (Benge and Wherry, l. c.). *Chalcopyrite:* auriferous and argentiferous; occurs 1/2 mile to the north (Benge and Wherry, l. c.) *Platinum?* has been reported in black shales in the vicinity.

GILBERTVILLE.

Malachite: traces occur in a roadside exposure, 1 1/2 miles south of Gilbertville, about 3 miles southeast of Boyertown, in Triassic shales (Benge and Wherry, XIII, 1906, 41).

FRANCONIA TOWNSHIP

Gold: in gravels on Yoder's farm (Wetherill, 1853, 350). *Tin?* in gravels (Wetherill, l. c.).

FREDERICK TOWNSHIP

HENDRICKS STATION. Young's mine on the west side of Perkiomen Creek, 3/8 mile northwest of Hendricks Sta., P. & R. Ry. Triassic shales. Idle.

Calcite: crystals (Benge and Wherry, XIII, 1906, 110). *Epidote:* (Benge and Wherry, l. c.). *Gold?* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Bornite:* (Benge and Wherry, l. c.) *Cuprite:* (Benge and Wherry, l. c.) *Malachite:* (Benge and Wherry, l. c.). *Chrysocolla:* (Benge and Wherry, l. c.).

SCHWENKSVILLE. Mines on hill north of Mine Run, 1/2 mile west of Schwenksville. Abandoned. Dumps at mouth of tunnel and around shafts on top of hill. Triassic shales; hydrothermal veins.

Calcite: (Benge and Wherry, XIII, 1906, 110). *Fluorite:* (Benge and Wherry, l. c.). *Bornite:* (Benge and Wherry, l. c.). *Malachite:* (Benge and Wherry, l. c.).

LOWER MERION TOWNSHIP

PENCOYD.

Halotrichite: weathering product on Wissahickon gneiss at quarry west of Pencoyd Sta. P. & R. Ry. (Benge and Wherry, XIII, 1906, 65). *Titanite:* small crystals in gneiss near West Laurel Hill Cemetery (Rand, 1892, 180).

[210] Eyerman reported almandite from "Mathuly Mill, near Jenkintown" (Eyerman, 1889, 18). Beryl has also been reported (Benge and Wherry, XIII, 1906, 91).

FLAT ROCK TUNNEL. On the P. & R. Ry. about 1 mile N. W. of West Manayunk Station. Wissahickon gneiss and pegmatite. Most of the minerals were obtained when the tunnel was constructed and the adjoining road widened. Dumps occur along river bank.

Microcline: crystals (Rand, 1867, 275). *Albite:* (Rand, l. c.). *Almandite:* (Genth, 1871, 73). *Beryl:* (Rand, l. c.). *Apatite:* yellow prismatic crystals with ilmenite. *Muscovite:* (Benge and Wherry, XIII, 1906, 66). *Ilmenite:* (Benge and Wherry, l. c.). *Calcite:* (Genth, 1875, 154). *Stilbite:* (Dana, 1850, 656). *Heulandite:* (Rand, 1867, 275). *Chabazite:* (Dana, 1850, 656).

GLADWYNE.[211] Eldredge and Steward's quarry, on P. & R. Ry. about 1/2 mile northwest of Gladwyne Station. Wissahickon gneiss.

Microcline: (Benge and Wherry, XIII, 1906, 66). *Adularia:* druses of small crystals. *Almandite:* small dodecahedra are abundant (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Gypsum?* (Benge and Wherry, l. c.).

SOAPSTONE QUARRY, 1/4 mile west of Eldredge and Steward's quarry.

Genthite? stains on chlorite schists. *Actinolite:* occurs in boulders on top of hill to the north.

OPPOSITE LAFAYETTE. Soapstone quarry on the west side of the Schuylkill River, opposite Lafayette; about 3/4 mile N. W. of Gladwyne Station. Meta-peridotite and meta-pyroxenite.

Hornblende: (Benge and Wherry, XIII, 1906, 66). *Amphibole asbestus:* (Rand, 1892, 182). *Talc:* greenish-white, foliated (Benge and Wherry, l. c.). *Chlorite:* (Benge and Wherry, l. c.). *Dolomite:* crystals and crystalline masses (Benge and Wherry, l. c.). *Breunnerite:* perfect crystals in dolomite (Rand, 1892, 181). *Corundum:* small crystals were found in chlorite schists on the hillside above the quarry. *Magnetite:* small octahedra in chlorite schists (Benge and Wherry, l. c.). *Ilmenite:* perfect tabular crystals measuring 2 cm.

ROSE'S QUARRY. At forks of road, 1/4 mile west of Schuylkill River, and 3/4 mile south of Woodland Sta., P. & R. Ry. Abandoned. Pyroxenite; and meta-peridotite.

Primary: *Enstatite:* cleavage masses (Rand, 1871, 303; Genth, 1875, 62; Hall, 1881, 129, analysis by Trimble). *Hypersthene:* (Benge and Wherry, XIII, 1906, 66).

Hydrothermal metamorphs: *Tremolite:* (Dana, 1892, 1069). *Amphibole absestus.* (Genth, 1875, 69). *Serpentine; antigorite:* dark green, slaty (Rand, 1871, 303). *Talc:* (Dana, 1892, 1069). *Prochlorite:* olive-green, scaly masses (Genth, 1875, 133; analysis by Castle). *Dolomite:* (Dana, 1892, 1069). *Bornite:* (Dana, l. c.). *Millerite:* (Dana, l. c.).

Weathering products: *Aragonite:* (Dana, 1892, 1069). *Epsomite:* (Benge and Wherry XIII, 1906, 66). *Neolite?* yellow or grayish-white, waxy, massive, veins in serpentine (Genth, 1875, 105; analysis by Jayne). *Genthite:* (Dana, l. c.). *Chalcanthite:* (Dana, l. c.).

LOWER POTTSGROVE TOWNSHIP

POTTSTOWN. Bleim's mine, about 1/2 mile northeast of Pottstown, on the road to Ringing Rocks. Triassic shales. At several points in the vicinity copper mines have been opened, but nothing more than traces of malachite were found.

Malachite: (Benge and Wherry, XIII, 1906, 41). *Chrysocolla:* (Benge and Wherry, l. c.) *Aragonite:* at roadside exposures nearby (Benge and Wherry, XIII, 1906, 41).

LOWER PROVIDENCE TOWNSHIP

ARCOLA. Dr. J. W. Griffiths farm, near the mouth of Skippack Creek, east of Arcola Station, P. & R. Ry. Triassic shales.

Malachite: large green masses (Lyman, 1898, 420).

PERKIOMEN COPPER MINE. On the north bank of Mine Run, about 1/2 mile northwest of Audubon,[212] and 1 mile east of Oaks Station, P. & R. Ry. The mines are abandoned, and the dumps rather barren. Triassic shales; hydrothermal veins.

Hydrothermal veins; primary: *Quartz:* crystals, stellated, cavernous, and pseudomorphous (Woodhouse, 1808, 133; Seybert, 1808, 154; Wetherill, 1825, 315). *Calcite:* (Benge and Wherry, XIII, 1906, 42). *Ankerite:* small crystals and crystalline masses (Dana, 1868, 779; Genth, 1875, 158). *Barite:* white, greenish and bluish, transparent; tabular crystals, usually

[211] Formerly Rose Glen.
[212] Formerly Shannonville.

in clusters, radiations, or fascicular groups (Mease, 1807, 409; Wetherill, 1825, 315; Genth, 1875, 46). *Galena:* massive, granular, crystalline masses; cubes and cubo-octahedra (Cleaveland, 1816, 514; Wetherill, 1825, 311). *Sphalerite:* yellow, brown, and black; massive, cleavable (Mease, 1807, 423; Seybert, 1808, 209). *Greenockite:* (Tomlinson, 1902, 119). *Pyrite:* (Woodhouse, 1808, 123). *Arsenopyrite:* large yellowish-white masses (Lea, 1818, 466; Genth, 1875, 209). *Chalcopyrite:* (Cleaveland, 1816, 453). *Hematite:* specular (Cleaveland, 1816, 489). *Dioptase?* Bright green rhombohedra (Tomlinson, 1902, 121).

Hydrometamorphs: *Bornite:* large vari-colored masses. *Covellite:* deep blue crystalline masses, rarely in microscopic hexagonal plates; thin coatings on galena (Genth, 1875, 23). *Marcasite?* (Tomlinson, 1902, 119).

Weathering products: *Chalcedony:* botryoidal (Genth, 1876, 218). *Silver:* (Benge and Wherry, XIII, 1906, 42). *Copper:* massive and dendritic (Cleaveland, 1822, 555). *Limonite:* (Schaeffer, 1818, 236). *Melaconite:* massive, pulverulent (Genth, 1875, 31). *Cuprite; chalcotrichite;* brilliant red, translucent, capillary crystals; octahedra (Lea, 1818, 463; Wetherill, 1825, 313). *Smithsonite:* white, pale blue, brown; reniform, radiated, drusy, (Cleaveland, 1822, 658; Wetherill, 1825, 314). *Cerussite:* (Cleaveland, 1816, 517; Wetherill, 1825, 311). *Malachite:* (Mitchell, 1813, 125, analysis). *Azurite:* minute dark blue crystals (Cleaveland, 1816, 461; Lea, 1818, 462). *Calamine:* (Cleaveland, 1816, 534). *Chrysocolla:* (Dana, 1850, 656). *Pyromorphite:* (Godon, 1810, 30; Wetherill, 1825, 313). *Mimetite:* (Benge and Wherry, l. c.). *Libethenite:* (Genth, 1875, 141). *Pseudomalachite:* (Rand, 1867, 404). *Anglesite:* (Lea, 1818, 467; Wetherill, 1825, 312). *Wulfenite:* yellow, tabular and pyramidal crystals (Cleaveland, 1816, 524; Wetherill, 1825, 313).

ECTON MINE. About 1/2 mile south of the Perkiomen copper mine. Triassic shales and hydrothermal veins. The mines are abandoned; dumps occur about the shaft on top of the hill, and tunnels at the base of the hill along Mine Run. The Wetherill mine was situated 1/2 mile to the south.

Hydrothermal veins; primary: *Quartz:* crystals, stellated (Benge and Wherry, XIII, 1906, 43). *Dolomite:* (Benge and Wherry, l. c.). *Ankerite:* (Benge and Wherry, l. c.). *Fluorite?* (Benge and Wherry, l. c.). *Barite:* (Eyerman, 1889, 41). *Galena:* argentiferous; granular, cleavage masses; cubo-octahedra (Genth, 1875, 11). *Sphalerite:* yellow, brown, black, crystalline masses (Genth, 1875, 14 analysis by Jayne). *Pyrite:* (Benge and Wherry, l. c.). *Arsenopyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Millerite?* (Benge and Wherry, l. c.). *Hematite:* (Benge and Wherry, l. c.).

Hydrometamorphs: *Chalcocite:* (Eyerman, 1889, 4, 34). *Bornite:* (Benge and Wherry, l. c.). *Covellite:* (Benge and Wherry, l. c.). *Marcasite?* (Benge and Wherry, l. c.).

Weathering products: *Chalcedony:* (Benge and Wherry, l. c.). *Copper:* (Benge and Wherry, l. c.). *Cuprite:* (Benge and Wherry, l. c.). *Limonite:* (Benge and Wherry, l. c.). *Cerussite:* (Genth, 1875, 163). *Hydrozincite:* (Benge and Wherry, l. c.). *Malachite:* (Benge and Wherry, l. c.). *Azurite:* (Benge and Wherry, l. c.). *Chrysocolla:* (Benge and Wherry, l. c.). Calamine: greenish-blue, cupriferous; small crystals and botryoidal masses (Genth, 1875, 106). *Pyromorphite:* pale green, botryoidal (Genth, 1875, 106). *Pseudomalachite:* (Benge and Wherry, l. c.). *Anglesite:* small colorless crystals (Genth, 1875, 147). *Wulfenite:* wax-yellow to bright orange, tabular crystals (Genth, 1875, 145).

SHANNONVILLE COPPER MINE. About 1/4 mile east of Audubon. Triassic shales.

Chalcopyrite: (Benge and Wherry, XIII, 1906, 43). *Malachite:* (Benge and Wherry, l. c.)

LOWER SALFORD TOWNSHIP

LEDERACHSVILLE.

Malachite: traces in Triassic shales, in a quarry, 1 1/2 miles east of Lederachsville (Benge and Wherry, XIII, 1906, 42).

MORELAND TOWNSHIP

WILLOW GROVE.[213] Roadside exposures northwest of Willow Grove. Baltimore gneiss.

Oligoclase: (Genth, 1875, 77). *Zircon:* small crystals in quartz in the soil (Lea, 1818, 470; Genth, 1875, 77).

[213] Troost (1821, 77) described zircon crystals, 1/4 inch long as occurring on Old York Road, 15 miles from Philadelphia.

Rock exposure on side of hill, north of Edge Hill road, about 1 mile east of Willow Grove. Chickies quartzite. Also in the fields and washouts in the vicinity.

Quartz: (Benge and Wherry, XIII, 1906, 60). *Hornstone:* (Benge and Wherry, l. c.). *Hematite:* titaniferous (Benge and Wherry, l. c.).

HUNTINGTON VALLEY STATION. Jarrett's quarry at Huntington Valley Sta., P. & R. Ry. Baltimore gneiss.

Quartz: blue (Benge and Wherry, XIII, 1906, 60). *Hematite:* (Benge and Wherry, l. c.) *Pyrite:* (Benge and Wherry, l. c.). *Stilpnomelane?* (Eyerman, 1911, 15).

PAPER MILLS STATION. Hutchinson's quarry, just north of Paper Mills Station, P. & R. Ry. Baltimore gneiss and gabbro.

Quartz: blue, massive and crystallized (Benge and Wherry, XIII, 1906, 60; XV, 1908, 108). *Oligoclase:* green (Benge and Wherry, XIII, 1906, 60). *Hypersthene:* (Benge and Wherry, XV, 1908, 108). *Hornblende:* (Benge and Wherry, XIII, 1906, 60). *Almandite:* massive (Benge and Wherry, XIII, 1906, 60). *Biotite:* brown (Benge and Wherry, XIII, 1906, 60). *Pyrrhotite:* (Benge and Wherry, XIII, 1906, 60). *Pyrite:* crystals (Benge and Wherry, XIII, 1906, 60). *Chalcopyrite:* (Benge and Wherry, XV, 1908, 108). *Molybdenite:* (Benge and Wherry, XIII, 1906, 60). *Ilmenite:* (Benge and Wherry, XV, 1908, 108). *Calcite:* crystals (Benge and Wherry, XV, 1908, 108).

NEW HANOVER TOWNSHIP

LANGFIELD.

Malachite: traces in Triassic shales in exposures on the north side of road near Langfield, 3 miles east of Gilbertsville. (Benge and Wherry, XIII, 1906, 41).

NORRITON TOWNSHIP

NORRISTOWN.

Quartz: (Lea, 1818, 473).

PERKIOMEN TOWNSHIP

GRATERS FORD.

Malachite: (Benge and Wherry, XIII, 1906, 91). *Azurite:* (Benge and Wherry, l. c.).

PLYMOUTH TOWNSHIP

CONSHOHOCKEN.

Quartz: aventurine, red (Rand, 1867, 190). *Chalcedony; hornstone:* (Genth, 1875, 59). *Tourmaline:* fibrous (Rand, l. c.). *Phyllite:* small greenish-black scales in siliceous limestone (Rand, l. c.; Genth, 1875, 135). *Ilmenite:* in quartz (Rand, l. c.).

JACOBY'S QUARRY on Plymouth Creek, about 1/2 mile north of Conshohocken. Shenandoah limestone.

Calcite: (Genth, 1875, 153).

O'BRIEN'S QUARRY, 1 mile north of Conshohocken. Shenandoah limestone.

Calcite: crystals (Carter, 1886, 19).

QUARRY near Ivy Rock Sta., P. R. R. about 1 mile north of Conshohocken. Shenandoah limestone.

Calcite: (Benge and Wherry, XIII, 1906, 65). *Dolomite:* crystals (Benge and Wherry, l. c.). *Quartz:* crystals (Benge and Wherry, l. c.). *Graphite:* (Benge and Wherry, l. c.).

MOGEETOWN. Exposure on north side of P. R. R. at entrance to a deep abandoned quarry; 1/8 mile N. W. of Trenton Cut-off bridge. Shenandoah limestone.

Quartz: crystals (Benge and Wherry, XIII, 1906, 65). *Calcite:* crystals (Benge and Wherry, l. c.). *Fluorite:* blue (Benge and Wherry, l. c.). *Barite:* small crystals (Benge and Wherry, l. c.).

Cut of P. & R. Ry. a short distance southeast of the preceding locality. Pegmatite.

Quartz: stalactitic (Benge and Wherry, XIII, 1906, 65). *Tourmaline:* (Benge and Wherry l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Malachite:* (Benge and Wherry, l. c.).

Loose rocks along the road from Mogeetown to Springtown, and in the adjacent fields; 9/8 mile north of Chestnut Hill—Norristown Trolley line. Chickies quartzite.

Quartz: crystals (Benge and Wherry, XIII, 1906, 111).

SPRINGFIELD TOWNSHIP[214]

CAMP HILL. Schlimme's quarry, 1/2 mile southeast of Camp Hill Sta., just south of P. & R. Ry. Shenandoah limestone.

Quartz: crystals (Benge and Wherry, XIII, 1906, 61). *Calcite:* yellow (Benge and Wherry, l.c.). *Dolomite:* crystals (Benge and Wherry, l. c.).

ORELAND. Iron ore pits about 1 mile southwest of Oreland Sta., P. & R. Ry. Abandoned. Some of the minerals have been found in the railroad cut 1/4 mile south of the station. Shenandoah limestone; Pensauken gravels; residual deposits of goethite.

Quartz: crystals (Benge and Wherry, XIII, 1906, 61). *Hematite?* micaceous (Carter, 1886, 19). *Goethite:* brown, fibrous; geodic (Genth, 1875, 48). *Lepidocrocite:* minute crystalline coatings on goethite (Genth, 1875, 48). *Turgite:* coatings on goethite (Genth, 1875, 47). *Limonite:* (Genth, 1875, 48). *Braunite?* (Carter, l. c.) *Pyrolusite:* druses of minute crystals (Genth, 1875, 46). *Psilomelane, wad, asbolite:* (Genth, 1875, 46; Lewis, 1880, 243; Benge and Wherry, l. c.).

ROSLYN HEIGHTS. Roslyn Heights Station, P. R. R., about 2 miles northeast of Chestnut Hill, and 1 mile east of Flourtown.

Quartz: crystals in the soil (Benge and Wherry, XIII, 1906, 61). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.).

FLOURTOWN. McCloskey's quarry, about 1 mile S. W. of Flourtown. Shenandoah limestone.

Calcite: (Benge and Wherry, XIII, 1906, 61). *Fluorite:* crystals (Rogers, 1858, I, 214). *Tourmaline:* brown (Benge and Wherry, l. c.). *Rutile:* (Benge and Wherry, l. c.). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.).

TOWAMENCIN TOWNSHIP

LANSDALE. Roadside exposures and quarry, 1/4 mile northwest of Drake's Crossroads, about 2 miles northwest of Lansdale. Triassic shales.

Malachite: traces (Benge and Wherry, XIII, 1906, 43). *Aragonite:* (Benge and Wherry, l. c.).

UPPER DUBLIN TOWNSHIP

Hematite: micaceous, on the road from Jarrettown to Camp Hill (Cleaveland, 1816, 488; Carter, 1886).

UPPER HANOVER TOWNSHIP

PENNSBURG. Cut of P. & R. Ry. 1/2 mile S. E. of Pennsburg Station. Triassic shales.

Pyrite: (Benge and Wherry, XV, 1908, 108). *Chalcopyrite:* (Benge and Wherry, l. c.) *Malachite:* traces; also occurs in roadside exposures about 1/4 mile northeast of the station (Benge and Wherry, XV, 1908, 108; XIII, 1906, 41).

UPPER MERION TOWNSHIP

WEST CONSHOHOCKEN. Exposures in northern part of West Conshohocken, on road to Bridgeport. Triassic intrusive dike of diabase.

Stilbite: also found at the continuation of the dike on the east side of the river (Benge and Wherry, XIII, 1906, 66).

BULLOCK'S QUARRY, about 1/2 mile north of West Conshohocken, on P. & R. Ry. Abandoned. Shenandoah limestone.

Quartz: crystals (Rand, 1892, 185). *Calcite:* seams of crystals (Rand, 1867, 190). *Aragonite:* (Rand, 1867. 190). *Sillimanite?* (Carter, 1886, 19). *Arsenopyrite?* (Benge and Wherry XIII, 1906, 66). *Graphite:* (Benge and Wherry, l. c.).

MCVOY'S QUARRY, about 3/4 mile north of West Conshohocken, near P. & R. Ry. Shenandoah limestone.

Calcite: scalenohedra (Benge and Wherry, XIII, 1906, 66). *Kaolinite:* (Benge and Wherry, l. c.). *Titanite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.).

SWEDELAND. Quarry about 1/2 mile west of Swedeland Furnace, and 1 1/2 miles south of Bridgeport. Shenandoah limestone. Idle.

[214] Eyerman (1889, 44) listed siderite from Springfield township.

Quartz: crystals (Benge and Wherry, XIII, 1906, 66). *Calcite:* crystals (Benge and Wherry, l. c.).

BRIDGEPORT. Exposures along road paralleling Trenton Cut-off R. R , about 3/4 mile west of Schuykill River, just south of Bridgeport. Shenandoah limestone.

Quartz: crystals in clusters and geodes (Dana, 1850, 656). *Goethite:* microscopic crystals (Benge and Wherry, XIII, 1906, 67).

SHAINLINE. Quarry at Shainline, about 1 mile west of Bridgeport, on P. & R. Ry. Shenandoah limestone.

Quartz: crystals (Carter, 1886). *Chalcopyrite:* (Benge and Wherry, XIII, 1906, 67). *Malachite:* crystals (Benge and Wherry, l. c.). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.).

HENDERSON. Farm along east side of P. & R. Ry. about 1/4 mile northeast of Henderson Station. Shenandoah limestone.

Limonite pseudo. *pyrite:* crystals in the soil (Rand, 1892, 186).

HENDERSON'S QUARRY, about 3/4 mile south of Henderson Station. Shenandoah limestone. Abandoned.

Calcite: crystals (Dana, 1850, 656). *Dolomite:* crystals (Benge and Wherry, XIII, 1906, 66). *Quartz:* crystals (Benge and Wherry, XIV, 1907, 42). *Malachite:* crystals (Benge and Wherry, XIII, 1906, 66). *Graphite:* (Benge and Wherry, l. c.).

Cut of P. & R. Ry. west of Henderson Station. Shenandoah limestone.

Quartz: doubly terminated crystals; single and in clusters (Genth, 1875, 56). *Calcite:* (Benge and Wherry, XIII, 1906, 67). *Dolomite:* (Benge and Wherry, l. c.). *Hematite:* (Benge and Wherry, l. c.). *Goethite:* geodes and rattle-boxes (Benge and Wherry, l. c.). *Turgite:* (Benge and Wherry, l. c.). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.). *Graphite:* (Benge and Wherry, l. c.).

KING OF PRUSSIA. Quarry about 1/2 mile southeast of King of Prussia. Shenandoah limestone.

Calcite: crystals (Benge and Wherry, XIII, 1906, 67). *Dolomite:* (Benge and Wherry, l. c.). *Muscovite, sericite:* (Benge and Wherry, l. c.). *Graphite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Sulfur:* (Benge and Wherry, l. c.).

Trenton Cut-off R. R., west of King of Prussia.

Quartz: doubly terminated crystals (Carter, 1886, 20).

PORT KENNEDY. Abandoned copper mine just east of Port Kennedy. Triassic shales.

Chalcopyrite: (Benge and Wherry, XIII, 1906, 67). *Malachite:* (Benge and Wherry, l. c.).

UPPER POTTSGROVE TOWNSHIP

Copper: (Cleaveland, 1822, 555). *Malachite:* traces occur in Triassic shales near Glasgow, just northwest of Pottstown, and in roadside exposures 1/8 mile north of Pottstown City Line (Benge and Wherry, XIII, 1906, 40, 41).

UPPER PROVIDENCE TOWNSHIP

COLLEGEVILLE.

Calcite: crystals in a quarry in Triassic shale, along P. & R. Ry. 1/2 mile north of Collegeville Sta. (Benge and Wherry, XIII, 1906, 42). *Malachite:* traces in Triassic shales in a quarry, 3/4 mile north of Collegeville (Benge and Wherry, XIII, 1906, 42).

UPPER SALFORD TOWNSHIP

SUMNEYTOWN.

Malachite: traces occur in Triassic shales, in roadside exposures: at cross-roads 1 1/2 miles east of Sunneytown; and 1 mile east of Sumneytown; (Benge and Wherry, XIII, 1906, 41).

KOBER'S FARM. Abandoned mine 1 mile southeast of Sumneytown. Triassic shales. Intrusive diabase; hydrothermal veins.

Shales; hydrothermal metamorphs: *Garnet:* (Benge and Wherry, XV, 1908, 108). *Epidote:* (Eyerman, 1911, 9, analysis).

Diabase; hydrothermal metamorphs: *Stilbite:* (Benge and Wherry, XV, 1908, 108). *Natrolite:* (Benge and Wherry, XV, 1908, 108).

Hydrothermal veins; primary: *Quartz:* (Benge and Wherry, XIII, 1906, 110). *Calcite:* (Benge and Wherry, XIII, 1906, 42). *Copper:* (Carter, 1886, 12). *Chalcopyrite:* (Carter, l. c.).

Galena: (Eyerman, 1911, 19).

Hydrothermal veins; hydrometamorphs: *Bornite:* (Carter, l. c.).

Hydrothermal veins; weathering products: *Melaconite:* (Benge and Wherry, XIII, 1906, 110). *Malachite:* (Eyerman, 1889, 45). *Azurite:* (Wheatley, 1882, 36). *Chrysocolla:* (Benge and Wherry, XV, 1908, 108). *Pyromorphite:* (Eyerman, 1911, 19).

KARL'S MINE. 1/2 mile south of Sumneytown. Triassic shales; diabase; hydrothermal veins.

Shales; hydrothermal metamorphs: *Garnet:* yellow (Benge and Wherry, XIV, 1907, 42). *Epidote:* (Benge and Wherry, XV, 1908, 108).

Diabase; hydrothermal metamorph: *Stilbite:* crystals (Benge and Wherry, XV, 1908, 108).

Hydrothermal veins; primary: *Dolomite:* (Benge and Wherry, XV, 1908, 108). *Chalcopyrite:* (Benge and Wherry, XIII, 1906, 42). *Hematite:* (Benge and Wherry, XV, 1908, 108).

Hydrothermal veins; hydrometamorphs: *Chalcocite:* (Benge and Wherry, XIV, 1907, 42). *Bornite:* (Benge and Wherry, XIII, 1906, 110).

Hydrothermal veins; weathering product: *Malachite:* (Benge and Wherry, XIII, 1906, 42).

HENDRICK'S STATION.

Chalcopyrite: occurs in Triassic shales, in a cut on P. & R. Ry. 1/2 mile north of Hendrick's Station (Benge and Wherry, XIII, 1906, 42). *Malachite:* occurs in Triassic shales in the above mentioned railroad cut, and also in exposures along the east bank of Perkiomen Creek, 1/2 mile northeast of Schwenksville and in road cuts in the immediate vicinity (Benge and Wherry, XIII, 1906, 42).

WHITEMARSH TOWNSHIP

FORT WASHINGTON.

Pyrite: crystals occur in Chickies quartzite in a cut of P. & R. Ry. 1/2 mile south of Fort Washington Sta. (Benge and Wherry, XIII, 1906, 110).

BARREN HILL.

Almandite: a crystal measuring 12 cm. was found in digging a well at the Barren Hill Meeting House (Lea, 1818, 471). *Sulfur:* pulverulent or granular in quartz with pyrite (Schaeffer 1819, 237). *Hornstone:* at cross-roads (Lea, 1818, 473).

LAFAYETTE.

Small quarry on River Road, about 1/2 mile north of Lafayette Station, P. & R. Ry. Baltimore gneiss and pegmatite.

Microcline: light pink (Carter, 1891, 50). *Oligoclase:* (Benge and Wherry, XIII, 1906, 61). *Graphite:* (Benge and Wherry, XIII, 1906, 61). *Biotite:* (Carter, l. c.). *Zircon:* (Cleaveland, 1822, 298).

MARBLE HALL.[215] Hitner's iron mines, northeast of Marble Hall. Shenandoah limestone, residual deposits of goethite. Abandoned.

Quartz: crystals (Benge, 1899, 141). *Hematite:* (Benge and Wherry, XIII, 1906, 62). *Goethite:* geodes (Rand, 1867, 189). *Lepidocrocite:* druses of crystals (Rand, l. c.). *Turgite:* (Benge and Wherry, l. c.; Eyerman, 1911, 22, analysis). *Limonite:* (Rand, l. c.). *Pyrolusite:* delicate radiations (Rand, l. c.). *Wad:* (Rand, l. c.). *Graphite:* (Benge and Wherry, l. c.).

HITNER'S MARBLE QUARRY at Marble Hall, about 3 miles northwest of Chestnut Hill. Shenandoah limestone. Abandoned.

Calcite: scalenohedra (Genth, 1875, 153). *Dolomite:* (Carter, 1886, 19). *Quartz:* milky (Benge and Wherry, XIII, 1906, 62). *Fluorite:* (Benge and Wherry, l. c.). *Graphite:* (Benge and Wherry, l. c.). *Pyrite:* (Carter, 1886, 19). *Chalcopyrite:* (Benge and Wherry, l. c.). *Malachite:* (Benge and Wherry, l. c.). *Chrysocolla:* (Benge and Wherry, l. c.). *Wad:* cobaltiferous (Eyerman, 1889, 13). *"Aquacreptite:"* Genth, 1875, 122).

Smaller quarry northeast of Marble Hall.

Barite: grayish-white, granular masses (Rand, 1867, 188).[216]

One mile southwest of Hitner's iron mine. Octoraro schists.

[215] Cacoxenite occurs in the vicinity (Rand, 1867, 189).

[216] Called strontianite by Rogers (1858, 1, 215).

Goethite: (Dana, 1868, 779). *Turgite:* (Benge and Wherry, XIII, 1906, 62). *Limonite:* (Dana, l. c.). *Pyrolusite:* (Dana, l. c.). *Psilomelane; wad:* (Dana, l. c.).

SPRING MILL. Pott's quarry, about 1 mile north of Spring Mill, on road to Harmanville. Shenandoah limestone.

Calcite: crystals (Benge and Wherry, XIII, 1906, 62). *Dolomite:* grayish cleavage masses.

One mile south of Spring Mill.

Quartz: drusy (Lea, 1818, 475). *Chalcedony, jasper:* (Lea, l. c.).

Limonite pits in the vicinity of Spring Mill and Conshohocken. Many of these have been filled in and plowed over.

Siderite: (Dana, 1850, 655). *Goethite:* geodes (Dana, l. c.). *Lepidocrocite:* druses (Dana, l. c.; Genth, 1875, 48). *Turgite:* (Benge and Wherry, XIII, 1906, 91). *Limonite:* (Dana, 1868, 780). *Pyrolusite:* (Genth, 1875, 46). *Cacoxenite:* very fine specimens were found at Colwell's iron furnace, on the northeast bank of the Schuykill River at Conshohocken, which undoubtedly came from the immediate vicinity (Dana, 1850, 656; Rand, 1892, 185).

NORTHAMPTON COUNTY

BETHLEHEM TOWNSHIP[217]

Calamine: dark brown crystals, stalactitic, botryoidal, and granular coatings on limonite, at an abandoned mine shaft on S. D. von Steuben's farm, 1/4 mile west of Dryland Station (Eyerman, 1889, 29, 33).

BUSHKILL TOWNSHIP

Quartz: transparent crystals measuring 3 cm. at Crystal Spring, Blue Mountain (Genth, 1875, 56).

FORKS TOWNSHIP

EASTON.

Quartz: transparent crystals measuring 9 cm. Found on the court house grounds, and near Twelfth and Northampton Streets. (Finch, 1824, 240; Rogers, 1858, II, 711; Eyerman, 1889, 13, 34). *Flint, hornstone:* black (Seybert, 1808, 157; Cleaveland, 1816, 225).

CHESTNUT HILL[218] Quarries and exposures on Chestnut Hill, north of Easton, from the Delaware River to Bushkill Creek. Pre-cambrian gneisses, pegmatite, and hydrothermal metamorphosed limestone. The principal quarry is the Verdolite quarry on the River Road, 1 mile north of Easton; other quarries are in the immediate vicinity, and about 2 miles to the southwest, east of Bushkill Creek.

Calcite: white, pink, and red, cleavage masses (Finch, 1824, 389). *Strontiocalcite:* (Eyerman, 1904, 45). *Aragonite:* snow white, fibrous masses, intimately mixed with amphibole asbestus (Lesley, 1882, 79; Eyerman, 1889, 34). *Dolomite:* cleavage masses (Finch, l. c.). *Breunnerite:* (Genth, 1875, 158). *Fluorite:* (Eyerman, 1911, 23). *Barite?* (Eyerman, 1904, 45). *Celesite?* (Eyerman, 1904, 45). *Diopside; coccolite; salite:* grayish-green, green, cleavage masses and prismatic crystals(Eyerman, 1911, 4, analyses; Finch, l. c.). *Augite:* green (Finch, l. c.; Lesley, 1883, 79). *Actinolite; nephrite:* green, greenish-white, radiating, and compact (Finch, l. c.; Rogers, 1858, II, 712; Eyerman, 1904, 43; 1911, 5, analyses). *Tremolite:* white, crystallized (Finch, l. c.; Dana, 1850, 656; Genth, 1875, 64). *Amphibole asbestus, mountain-leather:* compact, ligniform; fibrous masses up to 65 cm. in length (Finch, l. c.; Eyerman, 1904 45; 1911, 5, analysis). *Hornblende:* (Finch, l. c.). *Wernerite:* pink, prismatic crystals, at the Mineral Spring Quarry (Finch, l. c.; Eyerman, 1911, 7, analysis). *Epidote:* dark green, small crystals (Finch, l. c.). *Topaz?* small cream-yellow crystals, at the northern contact of the serpentine-talc belt (Eyerman, 1891, 464). *Phlogopite:* (Eyerman, 1904, 45). *Biotite:* silver-white, green, and brown; lamellar masses and crystals measuring 5 cm. (Finch, l. c.; Rammelsberg, 1866, 809; Knop, 1887, 603; Eyerman, 1904, 46; 1911, 13; Grailich, 1854, 51; Bauer, 1869, 360). *Serpentine;* precious or noble; *retinalite, marmolite, bowenite, porcellophite, thermophyl-*

[217] Genth (1875, 76, 79, 80) lists epidote, allanite, and zircon as occurring 3/4 mile north of Bethlehem. This is doubtless an error.

[218] Chromite (Finch, 1824, 239) and zaratite (Eyerman, 1911, 23) have been reported, but their occurrence is extremely doubtful and needs confirmation.

lite and *chrysolite:* yellow, light to dark oily green, greenish or reddish-white; massive, granular (Finch, l. c.; Thomson, 1828, 48; Smith, 1855, 189; Eyerman, 1904, 47; 1911, 15, 17; Merrill, 1890, 599). *Talc:* green and silvery white masses (Finch, l. c.). *Chlorite; prochlorite:* light to bluish-green, compact, crystalline masses (Finch, l. c.; Eyerman, 1904, 46; 1911, 14, analyses), *Vermiculite; eastonite:* bright yellowish-green, inelastic scales and crystals, with compact tremolite (Merrill, 1890, 599; Clarke and Schneider, 1891, 249, analysis; Eyerman, 1911, 14). *Titanite:* (Finch, l. c.). *Zircon:* clove brown crystals up to 5 cm. in length were formerly found on Chestnut Hill, west of the Easton-Wind Gap road (Finch, l. c.; Genth, 1875, 76; Eyerman, 1911, 6; Rogers, 1858, II, 711; I, 95). *Graphite:* (Finch, l. c.). *Molybdenite:* (Eyerman, 1911, 21). *Pyrite:* cubes and pyritohedra (Finch, l. c.). *Chalcopyrite:* small sphenoids in talc (Eyerman, 1891, 464). *Chalcocite:* (Eyerman, 1904, 45). *Galena:* (Eyerman, 1904, 45). *Cuprite:* traces (Finch, l. c.). *Hematite:* micaceous (Finch, l. c.). *Magnetite:* (Finch, l. c.). *Ilmenite:* (Finch, l. c.). *Limonite* pseudo. *pyrite:* (Eyerman, 1891, 465). *Malachite:* traces (Finch, l. c.). *Hydromagnesite:* snow white coatings, at the southern contact of the serpentine talc belt (Eyerman, 1891, 464). *Gypsum:* tabular crystals (Lewis, 1882, 48).

Pegmatite; primary: *Orthoclase:* pink crystals (Eyerman, 1891, 465 ; 1904, 43 ; 1911, 3, analyses). *Tourmaline:* crystals on Bushkill Creek (Eyerman, 1904, 45). *Muscovite:* crystals (Eyerman, 1911, 13, analysis).

Hanover Township

Campbell's Hump.[219] Iron ore prospect, 3 miles north of Bethlehem. Pre-cambrian metamorphosed limestone, and intrusive gabbro.

Asbestus: fibrous veins. *Axinite:* colorless to pale brown crystals up to several cm. in length (Frazier, 1882, 439). *Titanite:* imperfect crystals in the limestone (Genth, 1875, 102).

Lower Saucon Township

Lehigh Mountain.

Allanite: a mass weighing 100 lbs. was found on South Mountain, south of Lehigh University. Allanite is not an uncommon mineral in the gneiss of this district (Genth, 1875, 80). *Muscovite:* (Eyerman, 1891, 465).

Hellertown.[220] Abandoned iron ore pit, 1 mile south of the center of Hellertown, and a quarter mile east of fork of road (Allentown 9147) Cambrian quartzite; Cambro-ordovician limestone; residual deposits of goethite.

Wavellite: small acicular crystals in divergent groups in brecciated sandstone (Eyerman, 1911, 20; Wherry, 1918, 379–380; list of forms and analysis). *Cacoxenite:* yellow needles and radiating spherical aggregates (Wherry, 1915, 508). *Beraunite:* deep brown nodular crusts and flat radiations up to 1 cm. on an iron stained quartzite, in the northeast corner of the pit (Wherry, 1915, 507, analysis). *Psilomelane:* (Wherry, 1915, 508).

Bingen. Limonite pits in the vicinity of Bingen. Cambrian quartzite; residual deposits of goethite.

Quartz: ferruginous aggregates of small brownish yellow crystals (Genth, 1875, 58). *Goethite:* geodes; fibrous masses. *Turgite:* (Genth, 1875, 46). *Pyrolusite:* small crystals in geodes (Genth, 1875, 46).

Leithsville. *Quartz:* crystals on Flint Hill (Eyerman, 1889, 13, 34). *Jasper:* brown (Genth, 1875, 60). *Malachite:* traces in Triassic rocks (Eyerman, 1889, 33, 34).

Redington. On South Mountain, south of Redington, about 5 miles east of Bethlehem. Precambrian gneisses and pegmatite.

Quartz; fibrous, cats-eye: (Genth, 1875, 58). *Chalcedony; prase:* leek-green, translucent (Genth, 1875, 59). *Orthoclase:* (Eyerman, 1891, 465). *Coccolite:* (Genth, 1875, 80). *Epidote:* greenish-yellow crystals and granular masses (Dana, 1854, 491; Genth, 1875, 97). *Allanite:* black masses, with a yellowish-brown crust due to decomposition; imperfect crystals (Dana, 1854, 491; Genth, 1855, 21; 1875, 80, analysis). *Andradite:* dark brown (Dana, 1854, 491;

[219] A small quarry in the metamorphosed limestone was opened up on the west side of Monocacy Creek, southeast of Pine Top. No axinite has been observed here, however.

[220] Smoky quartz crystals occur near Hellertown (Eyerman, 1889, 14); zircon crystals, 1 mile east of Hellertown (Genth, 1875, 76); and siderite and asbolite, at Wharton's mine, 3 miles from Hellertown (Eyerman, 1889, 12; 1911, 23).

Eyerman, 1911, 6, analysis). *Tourmaline:* fibrous masses and imperfect crystals (Dana, 1854, 491; Genth, 1875, 97). *Chlorite:* dark greenish-black, cryptocrystalline; resembling thuringite (Genth, 1875, 97). *Zircon:* small gray to brownish-black, more or less altered, prismatic crystals, rarely 1.5 cm. long (Smith, 1855, 189; Genth, 1875, 76). *Magnetite:* (Dana, 1854, 49). *Spinel:* black (Dana, 1854, 491). *Hematite; martite:* (Genth, 1875, 35).

UPPER NAZARETH TOWNSHIP

NAZARETH.

Quartz: transparent crystals up to 7.5 cm. in length, abundant in the soil; sometimes doubly terminated (Genth, 1875, 56).

WILLIAM TOWNSHIP

SOUTH EASTON. Limonite pits along the base of Morgan Hill, south of South Easton. Pits are located all along the road, 1/4 mile south of South Easton. Cambro-ordovician limestone; residual deposits of goethite.

Goethite: fibrous masses; geodes (Genth, 1875, 48). *Lepidocrocite:* druses of minute crystals (Genth, 1875, 48). *Turgite:* red coatings on the interior of geodes (Eyerman, 1911, 22, analysis). *Limonite:* (Genth, 1875, 48). *Psilomelane; wad; asbolite:* (Genth, 1875, 48; Eyerman, 1889, 12). *Halloysite:* (Genth, 1875, 122). Eyerman (1911, 18) gives an analysis of a pink clay containing Mn, from the Sampson mine in the triangle of the roads south of South Easton.

NORTHUMBERLAND COUNTY

SUNBURY. Doughty mine, 4 miles south of Sunbury, opposite Selinsgrove on the Susquehanna River. Bossardville (Helderberg) limestone.

Galena: (White, 1883, 100). *Sphalerite:* (White, l. c.). *Calamine:* (Dana, 1844, 265, 545).

PERRY COUNTY

NEW BLOOMFIELD.

Wavellite: has been reported to occur as minute crystals in *Gypidula galeata* (characteristic of the early Devonian) on the road between New Bloomfield and Dellville.

PHILADELPHIA

LAFAYETTE. Prince's Soapstone quarry, about 1/4 mile south of Lafayette Sta., P. & R. Ry., on the Schuylkill River. Meta-peridotite; meta-pyroxenite; meta-gabbro; Wissahickon gneiss and pegmatite. Idle.

Peridotite; primary, *Enstatite; bronzite:* (Leeds, 1875, 229). *Olivine:* (Benge and Wherry, XII, 1905, 159). *Pyrrhotite:* (Genth, 1875, 17).

Peridotite and pyroxenites, etc. Hydrothermal metamorphs: *Anthophyllite?* (Rand, 1867, 191; Leeds, 1875, 229). *Tremolite:* bladed masses (Browne, 1831, 519; Leeds, 1875, 229, analysis). *Actinolite; nephrite?* (Rand, 1892, 181; Cleaveland, 1816, 272). *Amphibole asbestus:* (Cleaveland, 1816, 328). *Hornblende:* dark green, fibrous and radiating (Genth, 1875, 69). *Epidote?* (Benge and Wherry, XII, 1905, 50). *Zoisite:* minute indistinct grayish and brownish crystals and crystalline masses with hornblende and albite (Genth, 1875, 81). *Chlorite; prochlorite:* foliated, massive: (Mease, 1807, 404; Genth, 1875, 133). *Clinochlore:* (Benge and Wherry, XII, 1905, 50). *Talc:* silvery-white and green foliated, masses (Mease, 1807, 404; Lewis, 1880, 252; Hall, 1881, 128, analysis by Genth). *Pyrophyllite?* greenish-white, radiating, with talc (Genth, 1875, 226). *Serpentine:* greenish-black, pseudomorphous after olivine (Browne, 1831, 519; Genth, 1875, 114). *Dolomite:* grayish-white, cleavage masses; small brilliant hexagonal crystals (Rand, 1867, 191; Genth, 1875, 156; Hall, 1881, 129, analysis by Genth). *Ankerite:* (Benge and Wherry, XII, 1905, 50). *Siderite?* (Dana, 1868, 780). *Breunnerite:* yellowish-white, becoming brown on exposure, rhombohedra in talc (Leeds, 1870, 63, analysis). *Apatite:* straw-yellow to honey-yellow hexagonal prisms in dolomite (Rand, 1867, 191; Genth, 1875, 139). *Barite?* (Rand, 1892, 81). *Pyrite:* (Benge and Wherry, XII, 1905, 50). *Chalcopyrite:* (Rand, 1867, 191). *Bornite:* (Rand, 1867, 191). *Millerite:* capillary crystals in dolomite

(Rand, 1880, 243). *Magnetite:* octahedra in chlorite schists (Mease, 1807, 404). *Ilmenite:* rhombohedral crystals (Carter, 1886, 19). *Rutile:* in dolomite (Rand, 1892, 181).

Weathering products: *Deweylite:* (Benge and Wherry, XII, 1905, 50). *Lithomarge?* (Benge and Wherry, XII, 1905, 50). *Genthite:* (Rand, 1892, 181). *Limonite:* (Benge and Wherry, XII, 1905, 159). *Malachite:* (Rand, 1892, 181). *Chrysocolla:* (Benge and Wherry, XII, 1905, 50). *Chalcanthite:* efflorescence (Rand, 1867, 191). *Epsomite:* efflorescence (Rand, 1867, 191; Eyerman, 1911, 20, analysis).

Wissahickon gneiss: *Almandite:* (Genth, 1875, 73). *Staurolite:* (Cleaveland, 1816, 203; Genth, 1875, 103).

Pegmatite; primary: *Albite:* (Genth, 1875, 91). *Oligiase:* pale bluish (Genth, 1876, 223, analysis).

P. R. R. Cut and exposures in woods, in the vicinity of Prince's quarry. Meta-pyroxenite; meta-peridotite, and meta-gaboro.

Actinolite: (Benge and Wherry, XII, 1905, 50). *Amphibole asbestus:* (Lewis, 1885, 121). *Hornblende:* (Benge and Wherry, XII, 1905, 50). *Serpentine* pseudo. *olivine:* (Benge and Wherry, XII, 1905, 159). *Talc:* (Benge and Wherry, XII, 1905, 50). *Magnetite:* octahedral crystals, often twinned, measuring 1 cm. (Benge and Wherry, XII, 1905, 50).

Weathering products: *Genthite:* green coatings on actinolite (Lewis, 1885, 121). *Epsomite:* efflorescence (Lewis, l. c.).

Rocks in adjacent woods, east of Prince's Quarry. Debris from old excavations.

Oligoclase? (Benge and Wherry, XII, 1905, 50). *Almandite:* (Benge and Wherry, l. c.). *Tremolite:* (Benge and Wherry, l. c.) *Ilmenite:* (Benge and Wherry, l. c.).

Quarry near R. R., about ½ mile below Lafayette Sta., P. & R. Ry. Wissahickon gneiss and pegmatite. Abandoned.

Quartz: (Benge and Wherry, XII, 1905, 51). *Orthoclase:* (Benge and Wherry, XII, 1905, 51). *Albite:* (Benge and Wherry, XII, 1905, 51). *Almandite:* dodecahedral crystals are abundant; better crystals are found in the railroad cut north of the quarry (Benge and Wherry, XII, 1905, 51; Eyerman, 1911, 6, analysis). *Stilbite:* (Benge and Wherry, XII, 1905, 51). *Heulandite:* (Benge and Wherry, XII, 1905, 159). *Chabazite:* (Benge and Wherry, XII, 1905, 51). *Laumontite:* (Benge and Wherry, XII, 1905, 51). *Pyrite:* (Benge and Wherry, XII, 1905, 51). *Chalcopyrite:* (Benge and Wherry, XII, 1905, 51). *Ilmenite:* (Benge and Wherry, XII, 1905, 51). *Goethite:* (Benge and Wherry, XII, 1905, 51). *Limonite* pseudo. *pyrite:* (Benge and Wherry, XII, 1905, 51). *Epsomite:* efflorescence (Benge and Wherry, XII, 1905, 159).

SHAWMONT. Trolley cut on hillside, and exposures in the vicinity of Shawmont Sta., P. R. R. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XV, 1908, 107). *Albite:* (Benge and Wherry, l. c.). *Beryl:* (Browne, 1831, 518; Benge and Wherry, l. c.) *Almandite:* (Benge and Wherry, l. c.). *Cyanite:* (Browne, l. c.). *Tourmaline:* (Browne, l. c.; Benge and Wherry, l. c.) *Stilbite:* (Browne, l. c.). *Apatite:* (Browne, l. c.).

FLAT ROCK. Exposures on an island formed by the canal and the Schuylkill River, opposite Flat Rock Tunnel. Wissahickon gneiss and pegmatite.

Ilvaite: minute black crystals (Rand, 1867, 181). *Siderite?* (Rand, 1892, 182).

ROXBOROUGH. Filtration Plant, Port Royal Avenue, south of Ridge Avenue. Excavations, inaccessible. Wissahickon gneiss and pegmatite.

Spessartite? massive, reddish-brown (Lea, 1818, 472; Benge and Wherry, XII, 1905, 51). *Staurolite:* (Benge and Wherry, l. c.).

MANAYUNK. Leverington Ave., between Ridge Ave., and Main Street. Exposures made in street improvements. The same minerals have been found at many other exposures in Manayunk. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XII, 1905, 51). *Almandite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.).

WISSAHICKON STATION.[221] Exposures in the vicinity of Wissahickon Sta., P. & R. Ry. Wissahickon gneiss and pegmatite.

[221] On "Robinson Hill" of early writers.

Quartz: limpid crystals (Carpenter, 1828, 14). *Sillimanite:* on Ridge Avenue, just below Wissahickon Station[222] (Vanuxem, 1829, 43; Benge and Wherry, XII, 1905, 51). *Kaolinite:* (Benge and Wherry, XII, 1905, 51). *Graphite?* Carpenter, l. c.).

Chestnut Hill

Quartz: smoky (Seybert, 1808, 202). *Microcline:* (Seybert, l. c.). *Almandite:* small crystals (Seybert, l. c.). *Beryl:* (Mease, 1807, 400). *Tourmaline:* black (Seybert, l. c.). *Cyanite:* (Seybert, l. c.). *Muscovite:* green (Seybert, l. c.); *fuchsite:* (Lea, 1818, 477). *Corundum:* in pegmatite (Seybert, 1808, 202). *Hematite:* (Lea, 1818, 465). *Titanite:* (Dana, 1850, 656). *Apatite:* (Dana, 1850, 656).

Wissahickon Valley[223]

Exposures in the vicinity of Bell's Mill Road or Thorp's Lane, and Wissahickon Creek, Chestnut Hill. Wissahickon gneiss, pegmatite, meta-peridotite and meta-pyroxenite.

Wissahickon gneiss: *Almandite:* (Benge and Wherry, XII, 1905, 65). *Staurolite:* (Benge and Wherry, XII, 1905, 65). *Muscovite:* (Benge and Wherry, XII, 1905, 65). *Ilmenite:* (Benge and Wherry, XII, 1905, 65).

Pyroxenite and peridotite; hydrothermal metamorphs: *Actinolite; nephrite?* (Dana, 1850, 656; Benge and Wherry, XII, 1905, 65). *Tremolite:* (Dana, 1850, 656). *Amphibole asbestus:* (Lea, 1818, 466). *Hornblende:* (Benge and Wherry, XII, 1905, 159). *Serpentine:* (Dana, 1850, 656). *Chlorite:* (Benge and Wherry, XII, 1905, 65). *Talc:* foliated and radiated (Lea, 1818, 466). *Dolomite:* (Benge and Wherry, XII, 1905, 65). *Fluorite?* (Benge and Wherry, XII, 1905, 65). *Chalcopyrite:* (Benge and Wherry, XII, 1905, 65). *Magnetite:* (Lea, 1818, 463). *Chromite:* (Cleaveland, 1816, 508).

Exposures near Indian Rock, above Rex Avenue Valley, on the Wissahickon. Wissahickon gneiss.

Almandite: (Benge and Wherry, XII, 1905, 66). *Cyanite:* (Benge and Wherry, l. c.).

Exposures in the vicinity of Wise's Mill Road and Wissahickon Drive.[224] Wissahickon gneiss and pegmatite.

Quartz: clusters of crystals; drusy (Carpenter, 1828, 14). *Almandite:* (Dana, 1868, 780). *Staurolite:* (Lea, 1818, 472; Rand, 1867, 187). *Muscovite:* green (Benge and Wherry, XII, 1905, 66). *Apatite:* pale green prisms (Carpenter and Spackman, 1825, 246). *Hematite:* (Carpenter, 1828, 14). *Ilmenite:* (Rand, 1867, 187). *Rutile:* (Carpenter, 1828, 14).

Small quarry between Thorp's Land and Wise Mill Road.

Hyalite: (Rand, 1867, 187). *Muscovite:* green, in the vicinity of the quarry (Rand, 1867, 187). *Apatite:* pale brown crystals, near the quarry (Rand, l. c.).

Devil's Pool, mouth of Cresheim Creek, at Wissahickon creek. Wissahickon gneiss, pegmatite; meta-pyroxenite.

Exposures occur along the path 500 feet to the north, extending for some distance back over the hill; and 700 feet to the south of the pool; the minerals are also found in rock exposures and boulders in the creek and woods.

Wissahickon gneiss: *Almandite:* (Lea, 1818, 479; Rand, 1892, 182). *Staurolite:* rough brown crystals, often twinned, in schists on top of hill (Lea, l. c.; Rand, 1892, 182). *Cyanite:* at the contact of Wissahickon gneiss and the meta-peridotite dike (Lea, l. c.; Rand, 1892, 182). *Muscovite:* (Benge and Wherry, XII, 1905, 159).

Meta-pyroxenite; hydrothermal metamorphs: *Anthophyllite:* grayish-white, radiating masses (Carpenter and Spackman, 1825, 246). *Actinolite:* green, radiated (Lea, 1818, 479; Carpenter, 1825, 45). *Chlorite:* (Benge and Wherry, XII, 1905, 65). *Talc:* radiated masses (Carpenter, 1824, 236; Porter, 1824, 233). *Magnetite:* (Benge and Wherry, l. c.).

Exposures 1/2 mile above Devil's Pool.

Almandite: (Dana, 1892, 1070). *Staurolite:* (Dana, l. c.). *Muscovite:* (Dana, l. c. *Apatite:* (Dana, l. c.). *Ilmenite:* (Dana, l. c). *Hyalite:* (Dana, l. c.).

[222] The sillimanite locality is given by Vanuxem as "On the Schuylkill River, back of Robin Hood Tavern, on Ridge Road."

[223] Tourmaline occurs near Rittenhouse's paper mill (Carpenter, 1828, 14); and cyanite near Livezly's Mill (Carpenter, 1828, 14).

[224] Megargee's Paper Mill, Wise's Mill, etc. of earlier writers.

Exposures near Crease's Lane and Wissahickon Creek. Wissahickon gneiss, and pegmatite.

Hornstone: (Rand, 1867, 187). *Cyanite:* light to deep blue, bladed masses (Mease, 1807, 405; Rand, 1867, 187). *Staurolite:* (Rand, l. c.). *Tourmaline:* (Rand, l. c.). *Falunite?* (Benge and Wherry, XII, 1905, 65).

Exposures in the vicinity of Gorgas' Lane and Wissahickon Creek. Wissahickon gneiss and pegmatite.

Hornstone: (Rand, 1867, 187). *Cyanite:* light to deep blue, bladed masses (Mease, 1807, 405; Genth, 1875, 101). *Staurolite:* (Rand, l. c.). *Tourmaline:* radiating black crystals (Genth, 1875, 97). *Falunite?* (Benge and Wherry, XII, 1905, 66). *Ilmenite:* below Gorgas' Lane (Dana, 1863, 780). *Titanite:* (Genth, 1875, 102).

Weathering products: *Alunogen:* small silky fibrous incrustations on gneiss (Rand, 1867, 187; Genth, 1875, 101). *Halotrichite:* above Gorgas' Lane (Benge and Wherry, XII, 1905, 66).

RITTENHOUSE QUARRY,[225] west Rittenhouse Lane, between Wissahickon Creek and Wissahickon Avenue (Germantown, 7678). Meta-gabbro (hornblende gneiss), and pegmatite.

Pegmatite; primary: *Quartz:* (Benge and Wherry, XII, 1905, 66). *Microcline:* pink (Rand, 1867, 187). *Albite:* (Benge and Wherry, l. c.). *Hornblende, byssolite:* (Rand, l. c.; Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Sillimanite?* (Benge and Wherry, l. c.). *Tourmaline:* black crystals (Genth, 1875, 97). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Falunite?* pale green masses in microcline (Lewis, 1880, 313). *Epidote:* (Genth, 1875, 78). *Gadolinite?* (Benge and Wherry, l. c.). *Titanite:* crystals; *xanthitane;* (Genth, 1875, 102; Benge and Wherry, l. c.). *Apatite:* bluish-green, rough crystals up to 5 × 30 cm. (Rand, 1867, 187; 1892, 180; Eyerman, 1911, 18, analysis). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Bornite:* (Rand, l. c.). *Molybdenite:* (Benge and Wherry, l. c.). *Hematite:* (Benge and Wherry, XIII, 1906, 92).

Pegmatite; weathering products: *Jefferisite, philadelphite:* (Lewis, 1880, 313). *Limonite* pseudo. *pyrite:* (Benge and Wherry, XII, 1905, 66). *Malachite:* (Rand, l. c.). *Chrysocolla:* (Genth, 1875, 105; Rand, 1892, 180).

Meta-gabbro; hydrothermal metamorphs: *Calcite:* pink crystals (Benge and Wherry, XII, 1905, 66). *Pectolite?* (Benge and Wherry, l. c.). *Prehnite:* (Benge and Wherry, l. c.). *Apophyllite:* (Genth, 1875, 107; Eyerman, 1911, 11, analysis). *Stilbite:* white, radiating crystals (Rand, 1837, 187). *Heulandite:* small brown crystals (Rand, l. c.). *Chabazite:* (Benge and Wherry l. c.). *Natrolite:* (Rand, l. c.). *Laumonite:* small white crystals, sometimes colored green by Cu (Genth, 1875, 103; Rand, 1892, 180).

Gabbro; weathering product. *Hyalite:* blue and green (Benge and Wherry, XII, 1905, 66).

Exposures on Wissahickon Avenue, west of Rittenhouse Lane, about 1/8 mile north of Rittenhouse quarry. Wissahickon gneiss and pegmatite.

Sillimanite: fibrous masses (Genth, 1875, 98; Benge and Wherry, XII, 1905, 66). *Apatite:* (Benge and Wherry, l. c.).

FALLS OF SCHUYLKILL[226]

Quarries at Ridge Avenue and School Lane. The upper quarry has been filled in and is inaccessible. Wissahickon gneiss, pegmatite, and quartz veins.

Pegmatite; primary: *Microcline:* (Benge and Wherry, XIII, 1906, 92). *Sillimanite:* (Benge and Wherry, XII, 1905, 66). *Tourmaline:* (Benge and Wherry, XIII, 1906, 92). *Muscovite:* (Benge and Wherry, XII, 1905, 66). *Biotite:* (Benge and Wherry, XII, 1905, 66); *Jeffersite?* altered biotite (Benge and Wherry, XII, 1905, 66).

Hydrothermal veins, primary: *Amethyst:* light purple crystals, were found in the upper quarry. *Pyrite:* (Benge and Wherry, XII, 1905, 66). *Galena:* small cleavage masses. *Sphalerite:* brown, resinous, radiating crystals, probably paramorphous after wurtzite.

Hydrothermal veins; weathering products: *Limonite* pesudo. *pyrite:* (Benge and Wherry, XII, 1905, 66). *Pyromorphite:* minute green crystals.

[225] Formerly known as McKinney's quarry.

[226] Quartz crystals, hornblende and asbestus were found at a quarry on Ridge Avenue, below Queen Lane now abandoned and partially built over (Benge and Wherry, XII, 1905, 66).

Wissahickon gneiss; weathering products: *Alunogen:* (Benge and Wherry, XIII, 1906, 92; Eyerman, 1911, 21, analysis). *Halotrichite:* (Benge and Wherry, XIII, 1906, 92). *Glockerite:* yellow coatings (Benge and Wherry, XII, 1905, 66; Eyerman, 1911, 21, analysis).

GERMANTOWN[227]

Along Wissahickon Avenue.[228] Wissahickon gneiss and pegmatite.

Quartz: smoky (Carpenter, 1826, 14). *Actinolite:* (Carpenter, 1825, 45). *Spessartite:* brownish-red masses (Carpenter, 1825, 45). *Melanite?* (Lea, 1818, 470). *Epidote:* (Benge and Wherry, XII, 1905, 66). *Apatite:* (Benge and Wherry, XII, 1905, 66). *Titanite:* (Benge and Wherry, XII, 1905, 66).

TULPEHOCKEN STREET, east of Wayne Avenue. Street grading and improvements. Inaccessible. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XII, 1905, 67). *Almandite:* (Benge and Wherry, l. c.). *Cyanite:* (Benge and Wherry, l. c.). *Sillimanite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* crystals (Benge and Wherry, l. c.).

RITTENHOUSE LANE, east of P. R. R. Street grading. Wissahickon gneiss and pegmatite.

Muscovite: crystals (Benge and Wherry, XII, 1905, 67).

Exposure along P. R. R. south of Chelten Ave. Sta. Wissahickon gneiss and pegmatite.

Muscovite: large sheets (Benge and Wherry, XII, 1905, 67).

MCCREA'S QUARRY, Germantown Avenue and Mermaid Lane, Mt. Airy. Wissahickon gneiss and pegmatite.

Pegmatite; primary: *Microcline:* crystals (Benge and Wherry, XII, 1905, 89). *Oligoclase:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, XV, 1908, 107). *Tourmaline:* (Benge and Wherry, XII, 1905, 89). *Allanite:* (Wherry, 1908, 70). *Pyrite:* (Benge and Wherry, XV, 1908, 107). *Bornite:* (Benge and Wherry, XV, 1908, 107).

Pegmatite; weathering products: *Gummite:* (Wherry, 1908, 68). *Autunite:* (Benge and Wherry, XV, 1908, 107). *Torbernite:* small crystals (Benge and Wherry, XII, 1905, 89). *Uranophane:* (Benge and Wherry, XV, 1908, 107; Wherry, 1908, 68).

COMLY'S QUARRY, 1/4 mile east of McCrea's. Mt. Airy. Wissahickon gneiss and pegmatite.

Albite: (Benge and Wherry, XV, 1908, 107). *Zircon, cyrtolite:* (Benge and Wherry, XV, 1908, 107; Wherry, 1908, 72). *Torbernite:* green crystalline scales (Benge and Wherry, XV, 1908, 107; Wherry, 1908, 68).

Exposures along P. & R. Ry. near Mt. Pleasant Station, Mt. Airy. Wissahickon gneiss.

Almandite: (Benge and Wherry, XII, 1905, 89).

FOWLER'S QUARRY, East Johnson Street and P. & R. Ry. north of Walnut Lane Sta. Wissahickon gneiss and pegmatite.

Microcline: crystals (Benge and Wherry, XII, 1905, 89). *Albite:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.).

PENN STREET QUARRY, Penn St. and Bellfield Avenue. Wissahickon gneiss and pegmatite.

Pegmatite; primary: *Microcline:* crystals (Benge and Wherry, XII, 1905, 89). *Albite:* (Benge and Wherry, XII, 1905, 89). *Oligoclase:* (Benge and Wherry, XII, 1905, 160). *Hornblende:* (Benge and Wherry, XII, 1905, 160). *Almandite:* (Benge and Wherry, XII, 1905, 89). *Beryl:* (Benge and Wherry, XII, 1905, 89). *Tourmaline:* (Benge and Wherry, XII, 1905, 89).

[227] The following indefinite localities have been listed: A. C. Peale's farm: beryl (Lea, 1818, 472). Day's Cave, near residence of William Wister: microline and beryl (Carpenter, 1828, 14). Shoemaker's Lane: muscovite enclosing biotite (Lewis, 1880, 278). Rittenhouse Lane: allanite (Wherry, 1908, 70). West Washington Lane: tourmaline (Genth, 1875, 97). Eastern Germantown: apatite (Godon, 1810, 30). Germantown: apatite, adularia, almandite, beryl, cyanite, falunite, molybdenite, muscovite, sillimanite and spessartite: (Carpenter, 1825, 45; Carpenter and Spackman, 1825, 246; Wister, 1810, 31; Genth, 1873, 381; Nuttall, 1822, 22; Seybert, 1808, 256; Koenig, 1887, 38).

[228] Formerly the Roxborough-Germantown township line.

Sillimanite: (Benge and Wherry, XII, 1905, 89). *Muscovite:* (Benge and Wherry, XII, 1905, 89). *Biotite:* (Benge and Wherry, XII, 1905, 89). *Apatite:* (Benge and Wherry, XII, 1905, 89). *Molybdenite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.).

Pegmatite; weathering products: *Hyalite:* green coatings (Lewis, 1882, 49). *Chrysocolla:* (Benge and Wherry, XII, 1905, 89). *Torbernite:* (Benge and Wherry, XII, 1905, 89).

STENTON AVE., and Bellfield Ave., north of Wister Sta., P. & R. Ry. Exposures and sewer excavations. Wissahickon gneiss.

Hyalite: (Benge and Wherry, XII, 1905, 90).

Quarry on north side of P. & R. Ry. east of Penn Street. Abandoned. Wissahickon gneiss and pegmatite.

Microcline: crystals (Benge and Wherry, XII, 1905, 90). *Hornblende:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Muscovite:* crystals (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Stilbite:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Hematite:* (Benge and Wherry, l. c.). *Chrysocolla:* weathering product (Benge and Wherry, l. c.). *Torbernite:* (Benge and Wherry, l. c.).

Quarry about 1/2 mile N. E. of Fishers Sta., P. & R. Ry. Wissahickon gneiss and pegmatite.

Almandite: (Benge and Wherry, XII, 1906, 92). *Tourmaline:* black (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.).

Quarry at Ruscomb and Uber Streets, east of Fishers Sta., P. & R. Ry. Idle. Wissahickon gneiss and pegmatite.

Almandite: (Benge and Wherry, XII, 1905, 90). *Beryl:* (Benge and Wherry, l. c.). *Cyanite:* (Benge and Wherry, l. c.). *Sillimanite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.).

LOGAN STREET and Germantown Avenue. Street improvements. Inaccessible. Wissahickon gneiss and pegmatite.

Beryl: (Benge and Wherry, XII, 1905, 90). *Zoisite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.).

Cut on P. & R. Ry. 1/8 mile above Wayne Junction. Wissahickon gneiss and pegmatite.

Almandite: (Benge and Wherry, XII, 1905, 90). *Cyanite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.).

Quarry between Stenton Avenue and P. & R. Ry. near Germantown Ave. Wayne Junction Inaccessible. Hornblende gneiss (meta-gabbro).

Hornblende: (Lewis, 1880, 313). *Epidote:* (Lewis, l. c.). *Biotite; philadelphite:* (Lewis, l. c.). *Stilbite:* (Genth, 1875, 109). *Titanite:* (Lewis, l. c.). *Chalcopyrite:* (Lewis, l. c.). *Bornite:* (Rand, 1892, 180). *Malachite:* weathering product (Benge and Wherry, XII, 1905, 90).

WAYNE JUNCTION QUARRY, Roberts and Pulaski Avenues. The same minerals were found when the adjacent railroad was cut through. Wissahickon gneiss and pegmatite.

Almandite: (Benge and Wherry, XII, 1905, 90). *Beryl:* (Benge and Wherry, l. c.). *Sillimanite:* (Benge and Wherry, l. c.). *Zoisite:* (Benge and Wherry, l. c.). *Muscovite:* crystals (Benge and Wherry, l. c.). *Hyalite:* weathering product (Benge and Wherry, l. c.).

WAYNE QUARRIES, both side of Wayne Ave., between Wyoming Ave. and Seymour Street. Hornblende gneiss (meta-gabbro) and pegmatite.

Orthoclase: (Rand, 1892, 180). *Microcline:* (Benge and Wherry, XII, 1905, 90). *Albite:* (Benge and Wherry, l. c.). *Oligoclase:* (Benge and Wherry, l. c.). *Hornblende:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Epidote:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Biotite: lepidomelane? philadelphite:* (Benge and Wherry, l. c.; Rand, 1892, 180). *Falunite?* pale green masses in microcline (Lewis, 1882, 51). *Stilbite:* (Benge and Wherry, l. c.). *Kaolinite:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Titanite:* (Benge and Wherry, l. c.). *Molybdenite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Bornite:* (Benge and Wherry, l. c.). *Calcite:* pink (Benge and Wherry, l. c.). *Hyalite:* weathering product (Benge and Wherry, l. c.). *Malachite:* weathering product (Benge and Wherry, l. c.).

Branchtown

Norwood Cemetery (Magnolia Section) Old York Road and Haines Street. Street grading. Wissahickon gneiss and pegmatite.

Orthoclase: (Benge and Wherry, XII, 1905, 90). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* crystals (Benge and Wherry, l. c.).

Ogontz Avenue (19th Street) between Chelten Ave. and Haines St. Street grading. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XII, 1905, 91). *Hornblende:* (Benge and Wherry, l. c.). *Almandite:* crystals (Benge and Wherry, XII, 1905, 91; XIII, 1906, 92). *Tourmaline:* (Benge and Wherry, XII, 1905, 91). *Muscovite:* (Benge and Wherry, l. c.). *Hyalite:* (Benge and Wherry, l. c.).

East Chelten Ave. and Green Lane (or Godfrey St.). Old quarry and street grading. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XII, 1905, 91). *Almandite:* (Benge and Wherry, l. c.). *Muscovite:* crystals (Benge and Wherry, l. c.). *Kaolinite:* in a street grading at Broad Street and Green Lane (Benge and Wherry, XII, 1905, 91).

Tabor. Cut on P. & R. Ry. near Tabor Road. Wissahickon gneiss and pegmatite.

Beryl: (Benge and Wherry, XII, 1905, 107). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.).

Logan[229]

Broad Street between Logan Sta., P. & R. Ry. and Olney Avenue. Street cuts, sewer excavations, etc. in part inaccessible. Wissahickon gneiss and pegmatite.

Quartz: (Benge and Wherry, XII, 1905, 91). *Microcline:* crystals (Benge and Wherry, l. c.). *Albite:* (Benge and Wherry, l. c.). *Oligoclase:* at Broad St. and Clarkson Ave. (Benge and Wherry, l. c.). *Hornblende:* at Broad St. and Clarkson Ave. (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Beryl:* white, yellow and green (Carpenter, 1824, 236; Eyerman, 1911, 5, analysis). *Sillimanite:* on Broad Street at Clarkson Ave., and at Duncannon Ave. (Benge and Wherry, l. c.). *Cyanite:* on Broad St. at Clarkson Ave. (Benge and Wherry, l. c.). *Tourmaline:* black crystals (Carpenter, 1825, 45). *Muscovite:* greenish crystals measuring 15 cm. were found on the northwest corner of Broad St. and Olney Avenue (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Zircon; cyrtolite:* minute crystals at Broad St. and Olney Ave. (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Xenotime:* on Broad St. at Olney Avenue, and at Duncannon Ave. (Benge and Wherry, l. c.). *Columbite:* crystals on Broad St. at Olney Ave., and at Duncannon Ave. (Benge and Wherry, l. c.). *Ilmenite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Marcasite:* at Broad St. and Duncannon Ave. (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Autunite:* at Broad St. and Olney Ave. (Benge and Wherry, l. c.). *Uranophane:* on Broad St. at Olney Ave., and at Duncannon Ave. (Benge and Wherry, l. c.).

Excavations for improvements east of Logan Station, P. & R. Ry. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XII, 1905, 107). *Hornblende:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Kaolinite:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.).

Broad and Cayuga Streets. Grading on Torresdale Boulevard. Wissahickon gneiss and pegmatite.

Muscovite: large sheets (Benge and Wherry, XII, 1905, 107).

Nicetown

Midvale Steel Works. Nicetown Station. Hunting Park Ave. and Twenty-first Street. Inaccessible. Wissahickon gneiss and pegmatite.

Almandite: (Benge and Wherry, XII, 1905, 91). *Apatite:* (Benge and Wherry, l. c.).

Tioga. Tioga and Twentieth Street. Inaccessible. Hornblende gneiss (meta-gabbro).

[229] Carpenter (1825, 45) reported large limpid quartz crystals occurring in a field between Germantown and Old York Road, "5 miles from Philadelphia" (that is, the city line which was then at Spring Garden Street). The locality is probably in the valley of Wingohocking Creek, now used as a sewer. The valley is being filled in.

Oligoclase: (Benge and Wherry, XII, 1905, 91). *Hornblende:* (Benge and Wherry, l. c.). *Titanite:* brown crystals and crystalline masses (Hall, 1881, 130, analysis by Genth).

BUSTLETON. Exposures one-half mile east of Bustleton. Meta-pyroxenite.

Anthophyllite: (Benge and Wherry, XV, 1908, 107). *Actinolite:* radiating masses (Carpenter, 1828, 12). *Talc:* (Benge and Wherry, l. c.).

Exposures on Pennypack Creek, 1 mile southwest of Bustleton. Wissahickon gneiss and pegmatite.

Muscovite: (Carpenter, 1828, 13).

Exposures in woods, 1/4 mile east of Pennypack Creek, south of P. & R. Ry. Wissahickon gneiss and pegmatite.

Hornblende: (Benge and Wherry, XIII, 1906, 92). *Almandite:* (Benge and Wherry, l. c.).

Cuts on P. & R. Ry. between Bustleton and Pennypack Creek. Wissahickon gneiss and pegmatite.

Tourmaline: (Benge and Wherry, XIII, 1906, 92). *Muscovite:* (Benge and Wherry, XIII, 1906, 92). *Apatite:* crystals (Benge and Wherry, XV, 1908, 107).

VEREEVILLE[230]

Hillside exposures, 1 mile north of Vereeville. Wissahickon gneiss and pegmatite.

Almandite: (Benge and Wherry, XV, 1908, 107). *Cyanite:* (Carpenter, 1828, 12). *Staurolite:* (Benge and Wherry, XV, 1908, 107). *Tourmaline:* black crystals (Carpenter, l. c.).

FOX CHASE

Cuts and exposures on P. & R. Ry. between Rhawn Street and Pennypack Creek. Wissahickon gneiss and pegmatite. The material was dumped at the end of Pennypack bridge.

Tourmaline: crystals (Benge and Wherry, XII, 1905, 105). *Muscovite:* crystals (Benge and Wherry, XII, 1905, 105). *Biotite:* (Benge and Wherry, XIII, 1906, 92).

RYERS. Cut on P. & R. Ry. just south of Cottman Street. The material was dumped where the two railroads meet below Cheltenham Station. Wissahickon gneiss and pegmatite.

Microcline: crystals (Benge and Wherry, XIII, 1906, 92). *Oligoclase:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Kaolinite:* (Benge and Wherry, l. c.).

CHELTENHAM

Exposure opposite Cheltenham Sta., P. & R. Ry. Wissahickon gneiss and pegmatite.

Muscovite: crystals (Benge and Wherry, XIII, 1906, 92).

TORRESDALE. Filtration Plant, Tulip and Tolbut Streets. Construction excavations. Inaccessible. Hornblende gneiss (meta-gabbro).

Pyroxene: (Benge and Wherry, XII, 1905, 105). *Apatite:* crystals (Benge and Wherry, l. c.)

HOLMESBURG. Holmesburg Granite Co. quarry, Soley Ave. and Welsh Road. Granite gneiss and pegmatite.

Microcline: pink crystals (Benge and Wherry, XIII, 1906, 92). *Albite:* white crystals measuring 3 cm. *Almandite:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Fluorite:* violet coatings (Benge and Wherry, l. c.).

Exposures on Pennypack Creek, at the mouth of Sandy Run, 1 mile northwest of Holmesburg. Wissahickon gneiss and pegmatite.

Spessartite: massive, red (Carpenter, 1828, 12). *Apatite:* light green crystals in quartz (Carpenter, 1828, 13). *Psilomelane:* coating gneiss (Carpenter, 1828, 12).

BRIDESBURG. Sands and gravels of the Delaware River, just below the mouth of Frankford Creek.

Gold: scales (Genth, 1875, 2). *Magnetite:* grains (Genth, l. c.). *Ilmenite:* (Genth, l. c.). *Zircon:* minute colorless crystals (Genth, 1875, 77).

FRANKFORD

William's quarry, Penn Street and Little Tacony Creek, west of Frankford Avenue. Hornblende gneiss (meta-gabbro).

[230] This may be the old locality given by the early writers as "Nevil's Academy, near Bustleton."

Gabbro; hydrothermal metamorphs: *Quartz:* crystals (Benge and Wherry, XII, 1905, 160). *Hornblende:* (Benge and Wherry, XII, 1905, 106). *Crocidolite?* (Benge and Wherry, XII, 1905, 106). *Epidote:* (Benge and Wherry, XII, 1905, 160). *Pectolite:* (Benge and Wherry, XII, 1905, 106). *Apophyllite:* (Rand, 1892, 179). *Stilbite:* (Benge and Wherry, XII, 1905, 106). *Heulandite:* (Benge and Wherry, XIII, 1906, 92). *Natrolite:* (Benge and Wherry, XII, 1905, 160). *Fluorite:* (Benge and Wherry, XII, 1905, 160). *Magnetite:* (Benge and Wherry, XII, 1905, 106).

Weathering product: *Wad:* (Benge and Wherry, XII, 1905, 160).

BARBER'S QUARRY, Church and Leiper Streets, east of Frankford Creek. Abandoned and partially filled up. Hornblende gneiss (meta-gabbro) and pegmatite.

Gabbro; hydrothermal metamorphs: *Hornblende:* (Dana, 1868, 780). *Crocidolite:* (Benge and Wherry, XII, 1905, 106). *Epidote:* green crystals (Rand, 1871, 301; Genth, 1875, 78; Lewis, 1880, 243). *Calcite:* (Rand, 1871, 301). *Fluorite:* colorless to purple octahedra in calcite (Rand, 1871, 301; Genth, 1876, 210). *Pectolite:* (Eyerman, 1889, 28). *Apophyllite:* colorless to white crystals (Genth, 1875, 107). *Stilbite:* white, crystals and radiating aggregates measuring 3 cm. (Rand, 1867, 186; Genth, 1875, 109; 1876, 225, analysis). *Heulandite:* (Rand, 1890, 83). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Genth, 1875, 21). *Bornite:* (Genth, 1875, 13). *Magnetite:* (Genth, 1875, 38).

Meta-gabbro; weathering products: *Opal, hyalite:* white, yellow and green, fluorescent, coating fluorite (Rand, 1872, 301; Genth, 1875, 61). *Cuprite:* vermillion-red coatings on bornite (Lewis, 1885, 120). *Malachite:* (Genth, 1875, 167). *Chrysocolla:* (Genth, 1875, 105).

Pegmatite; primary: *Quartz:* smoky (Benge and Wherry, XII, 1905, 106). *Microcline:* white to pink, with microscopic inclusions of goethite (Rand, 1871, 300; Genth, 1875, 94). *Albite:* (Benge and Wherry, XII, 1905, 106). *Oligoclase:* greenish-white (Genth, 1867, 223, analysis) *Almandite:* (Benge and Wherry, l. c.). *Staurolite?* (Benge and Wherry, l c.). *Tourmaline:* black (Genth, 1875, 97). *Muscovite:* (Rand, 1890, 23). *Biotite, lepidomelane:* (Rand, 1890, 83). *Titanite:* small brown crystals (Genth, 1875, 102). *Apatite:* (Genth, 1875, 138). *Molybdenite:* hexagonal tabular crystals up to 10 × 5 cm., and foliated masses up to a pound in weight (Rand, 1867, 186; 1892, 178; Genth, 1875, 9; Brown, 1896, 210).

Pegmatite; weathering products: *Molybdite:* (Benge and Wherry, XII, 1905, 106). *Randite:* lemon-yellow coatings of microscopic acicular crystals at the south end of the quarry (Koenig, 1878, 408, analysis; Rand, 1880, 274).

PETER'S QUARRY, across Church Street from Barber's quarry. Inaccessible. Hornblende gneiss (meta-gabbro). *Hornblende:* crystals (Rand, 1892, 179). *Epidote:* fine crystals up to 5 cm. in a vein of calcite (Rand, l. c.). *Apatite:* (Rand, l. c.). *Calcite:* (Rand, l. c.). *Fluorite:* (Rand, l. c.). *Chalcopyrite:* (Rand, l. c.). *Bornite:* (Rand, l. c.). *Opal, hyalite:* greenish-yellow coatings due to weathering (Rand, l. c.). *Chrysocolla:* weathering product (Rand, l. c.).

HORROCK'S QUARRY, Unity and Wingohocking Streets. Inaccessible. Hornblende gneiss. *Microcline:* (Benge and Wherry, XII, 1905, 106). *Oligoclase:* greenish (Benge and Wherry, l. c.). *Randite:* (Benge and Wherry, XII, 1905, 106). *Sillimanite:* occurs near the quarry (Benge and Wherry, l. c.).

Quarries east of Wingohocking Sta., P. & R. Ry. Wissahickon gneiss and pegmatite.

Torbernite: (Wherry, 1908, 68).

CLARK'S QUARRY, Powder Mill Lane, west of Frankford Creek. Hornblende gneiss (meta-gabbro) and pegmatite.

Gabbro; hydrothermal metamorphs: *Hornblende:* cleavage masses. *Epidote:* olive-green crystals (Eyerman, 1911, 9, analysis). *Pectolite:* white, radiating aggregates. *Apophyllite:* (Benge and Wherry, XII, 1905, 106; Eyerman, 1911, 11, analysis). *Stilbite:* (Benge and Wherry, l. c.). *Chabazite:* yellowish-brown (Eyerman, 1911, 12, analysis). *Chalcopyrite:* Benge and Wherry, l. c.). *Chalcocite:* (Benge and Wherry, XV, 1908, 107). *Bornite:* (Benge and Wherry, XII, 1905, 106)).

Meta-gabbro; weathering products: *Malachite:* (Benge and Wherry, XII, 1905, 106). *Chrysocolla:* (Benge and Wherry, l. c.).

Pegmatite; primary: *Microcline:* (Benge and Wherry, XII, 1905, 106). *Wernerite:* white, faintly greenish crystals (Wherry, 1907, 37). *Biotite; lepidomelane:* (Eyerman, 1911, 14, analysis). *Titanite:* brown, twinned crystals. *Molybdenite:* disseminated masses.

Quarry on west side of Frankford Creek, northeast of Juniata Park, about Wingohocking and L Streets. Idle Hornblende gneiss (meta-gabbro) and pegmatite.

Gabbro; hydrothermal metamorphs: *Hornblende:* (Benge and Wherry, XII, 1905, 106). *Crocidolite:* (Benge and Wherry, XIII, 1906, 92). *Epidote:* crystals (Benge and Wherry, XIII, 1906, 92). *Calcite:* pink (Benge and Wherry, XIII, 1906, 92). *Stilbite:* brown, red, and yellow (Benge and Wherry, XII, 1905, 106; XIII, 1906, 92). *Heulandite:* (Benge and Wherry, XIII, 1906, 92). *Chabazite:* yellow crystals (Benge and Wherry, XIII, 1906, 92). *Pyrite:* often altered to limonite (Benge and Wherry, l. c.).

Pegmatite: primary: *Microcline:* (Benge and Wherry, XII, 1905, 106). *Oligoclase:* green (Benge and Wherry, XIII, 1906, 92). *Wernerite:* (Benge and Wherry, XIII, 1906, 92). *Tourmaline:* black (Benge and Wherry, XIII, 1906, 92). *Biotite:* (Benge and Wherry, XII, 1905, 106). *Apatite:* (Benge and Wherry, XIII, 1906, 92). *Titanite:* brown (Benge and Wherry, XIII, 1906, 92). *Molybdenite:* (Benge and Wherry, XIII, 1906, 92).

WYOMING AVENUE, east of Tacony Creek. Street improvements, inaccessible. Wissahickon gneiss and pegmatite.

Tourmaline: brown crystals (Benge and Wherry, XII, 1905, 106). *Muscovite:* (Benge and Wherry, l. c.). *Apatite:* crystals (Benge and Wherry, l. c.).

TACONY CREEK VALLEY

Hoffman's Quarry, east side of Tacony Creek, north of Fishers Lane. Abandoned. Hornblende gneiss (meta-gabbro) and pegmatite.

Gabbro; hydrothermal metamorphs: *Hornblende:* green (Benge and Wherry, XII, 1905, 106). *Epidote:* crystals (Benge and Wherry, XII, 1905, 106). *Calcite:* pink (Benge and Wherry, XII, 1905, 106). *Stilbite:* (Benge and Wherry, XII, 1905, 106). *Chabazite:* red crystals (Benge and Wherry, XIII, 1906, 92).

Pegmatite; primary: *Microcline:* (Benge and Wherry, XIII, 1906, 92). *Oligoclase:* (Benge and Wherry, XIII, 1906, 92). *Wernerite?* (Benge and Wherry, XIII, 1906, 92). *Tourmaline:* (Benge and Wherry, XIII, 1906, 92). *Allanite:* (Benge and Wherry, XIII, 1906, 92). *Biotite:* (Benge and Wherry, XII, 1905, 106). *Titanite:* (Benge and Wherry, XII, 1905, 106). *Scheelite:* crystals and masses in quartz (Benge and Wherry, XIII, 1906, 92; Eyerman, 1911, 22, analysis). *Hematite:* (Benge and Wherry, XIII, 1906, 92).

Washout, and isolated boulders in field northwest of Fishers Lane, between Tacony Creek and Wyoming Avenue. Wissahickon gneiss and pegmatite.

Quartz: smoky (MacFeeters, 1902, 83). *Amethyst:* crystals measuring 2.5 cm., enclosing rutile (MacFeeters, l. c.). *Microcline:* (MacFeeters, l. c.). *Hornblende:* (MacFeeters, l. c.). *Biotite:* altered (Benge and Wherry, XIII, 1906, 92; MacFeeters, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Hematite:* crystals (Benge and Wherry, l. c.). *Rutile:* acicular crystals (MacFeeters, l. c.). *Wad:* (MacFeeters, l. c.).

JERRY O'NEILL'S QUARRY, on the south side of Tacony Creek, east of P. R. R. bridge; about 1/4 mile north of Wyoming Avenue. Hornblende gneiss (meta-gabbro) and pegmatite.

Gabbro; hydrothermal metamorphs: *Hornblende:* greenish cleavage masses. *Epidote:* crystalline masses (Benge and Wherry, XIV, 1907, 42). *Biotite:* (Benge and Wherry, l. c.). *Calcite:* pink cleavage masses. *Stilbite:* yellowish, radiating. *Chalcopyrite:* small masses. *Bornite:* (Benge and Wherry, l. c.). *Covellite:* traces.

Meta-gabbro; weathering products: *Vermiculite:* brownish micaceous masses. *Cuprite:* red coatings on chalcopyrite. *Malachite:* green stains (Benge and Wherry, l. c.).

Pegmatite; primary: *Quartz:* small crystals (Benge and Wherry, XIV, 1907, 42). *Orthoclase, adularia:* colorless, white, and pink crystals (Benge and Wherry, l. c.). *Albite:* white crystals. *Wernerite:* white, prismatic crystals. *Rubellite?* pink crystals in albite, poor. *Apatite:* (Benge and Wherry, l. c.). *Titanite:* brown crystals measuring 2.5 cm.

CUT on Bustleton Br., P. R. R., between Wyoming Ave. and Fishers Lane. Pegmatite.

Tourmaline: (Benge and Wherry, XIII, 1905, 107). *Muscovite:* (Benge and Wherry, l. c.).

WYOMING AVENUE and Fishers Lane. Trolley construction, inaccessible. Wissahickon gneiss and pegmatite.

Quartz: rose (Benge and Wherry, XII, 1905, 107). *Almandite:* (Benge and Wherry, l. c.). *Ilmenite:* (Benge and Wherry, l. c.).

Wingohocking Creek Valley

Quarry on north side of Wingohocking Creek, 1/8 mile west of Harrowgate Lane. The quarry is abandoned; the following minerals were found on the extensive dumps. Wissahickon gneiss and pegmatite.

Quartz: limpid to milky crystals up to 50 × 30 cm. and weighing 80 pounds; in single individuals, or parallel groups. *Rutile:* veins of brilliant red, reddish-brown or black, reticulated acicular crystals, in milky quartz. *Ilmenite:* black tabular crystals in quartz. *Epidote:* green, radiating crystals in quartz.

Quarry on south side of Wingohocking Creek, east of Harrowgate Lane. Wissahickon gneiss and pegmatite.

Quartz: crystals (Benge and Wherry, XII, 1905, 107). *Microcline:* (Benge and Wherry, XII, 1905, 107). *Almandite:* (Benge and Wherry, l. c.). *Sillimanite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, XIV, 1907, 42).

Quarry on the south side of Wingohocking Creek, west of Harrowgate Lane. Hornblende gneiss (meta-gabbro), Wissahickon gneiss, and pegmatite.

Microcline: (Benge and Wherry, XII, 1905, 107). *Albite:* (Benge and Wherry, l. c.). *Oligoclase:* (Benge and Wherry, l. c.). *Hornblende:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Stilbite:* (Benge and Wherry, l. c.). *Titanite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Hyalite:* (Benge and Wherry, l. c.).

Fairmount Park

Quarry, near Falls of Schuylkill, south side of ravine below Chamounix Lakes, west of P. & R. Ry. Abandoned, and partially walled up to form the lower lake. Hornblende gneiss.

Gabbro; hydrothermal metamorphs: *Hornblende:* fibrous masses (Seybert, 1808, 159). *Asbestus:* fibrous with quartz (Lea, 1818, 478). *Crocidolite:* dark bluish, fibrous (Genth, 1875, 70; Rand). *Epidote:* (Genth, 1875, 78). *Zoisite:*[231] gray and pink, acicular crystals and pearly masses. (Lea, 1818, 470; Genth, 1875, 81; Rand, 1887, 1597). *Chlorite:* green foliated (Mead, 1822, 54). *Pyrite:* (Benge and Wherry, XIII, 1906, 93). *Pyrrhotite:* (Rand, 1892, 181). *Calcite:* scalenohedra (Rand, 1892, 181). *Fluorite:* purplish (Lea, 1818, 481). *Stilbite:* white, pearly, radiating (Seybert, 1808, 158). *Chabazite:* yellow (Genth, 1875, 109). *Laumontite:* (Genth, 1875, 104). *Analcite:* (Foote, 1880, 252).

Meta-gabbro; weathering product: *Halotrichite:* efflorescence (Rand, 1892, 181).

Pegmatite; primary: *Quartz:* modified crystals (Rand, 1887, 1597). *Orthoclase:* (Lea, 1818, 476). *Almandite:* (Genth, 1875, 73). *Tourmaline:* black (Genth, 1875, 97). *Muscovite:* (Genth, 1875, 85). *Apatite:* (Dana, 1892, 1070). *Titanite:* waxy-yellow and brown crystals (Bruce, 1813, 233).

Cuts along Strawberry Hill Drive, near the east end of Park Trolley Bridge. Wissahickon gneiss; hornblende gneiss, and pegmatite.

Quartz: crystals (Groth, 1903, 167). *Almandite:* (Groth, l. c.). *Cyanite:* in nodules of quartz (Rand, 1896, 484). *Sillimanite:* in quartz: (Rand, l. c.). *Tourmaline:* black (Groth, l. c.). *Halotrichite:* weathering product (Lewis, 1882, 50).

Exposures along East River Drive, north of Columbia Bridge. Hornblende gneiss.

Almandite: (Benge and Wherry, XII, 1905, 40). *Apatite:* (Benge and Wherry, l. c.) *Pyrite:* (Benge and Wherry, l. c.). *Calcite:* (Benge and Wherry, l. c.). *Stilbite:* (Benge and Wherry, l. c.). *Laumontite:* (Benge and Wherry, l. c.). *Halotrichite:* weathering product (Benge and Wherry, l. c.).

Quarry[232] on north side of P. & R. Ry., about 1/8 mile east of Columbia bridge. Hornblende gneiss and pegmatite.

Gabbro; hydrothermal metamorphs: *Hornblende:* (Benge and Wherry, XII, 1905, 140). *Actinolite:* (Genth, 1875, 68). *Calcite:* crystals (Genth, 1875, 154). *Stilbite:* (Leonhard, 1849, 825). *Heulandite:* (Rand, 1867, 275). *Chabazite:* (Groth, 1903, 167). *Natrolite:* (Benge and

[231] Called rhodonite by Rand.

[232] The quarry was opened to make room and furnish stone for an ice house erected in 1850. Subsequently this ice house burnt down, and a larger one was erected in its place. This has also disappeared.

Wherry, XII, 1905, 141). *Laumontite:* fine yellowish-white, prismatic crystals (Dana, 1844, 326).

Weathering products: *Epsomite:* (Benge and Wherry, XII, 1905, 141). *Alunogen:* (Groth, l. c.). *Halotrichite:* yellowish-white, silky-fibrous coatings (Genth, 1875, 150). *Glockerite:* brownish, resinous, stalactitic (Genth, 1875, 151).

Pegmatite; primary. *Quartz:* smoky and limpid crystals (Rand, 1867, 275). *Microcline:* (Genth, 1875, 93). *Almandite:* (Groth, l. c.). *Tourmaline:* (Groth, l. c.). *Muscovite:* (Groth, l. c.). *Ilmenite:* (Benge and Wherry, XII, 1905, 140). *Pyrite:* (Benge and Wherry, XII, 1905, 141).

Wissahickon gneiss: *Staurolite:* (Genth, 1875, 103). *Sillimanite:* (Genth, 1875, 98).

Exposures near the western end of Columbia Bridge. Wissahickon gneiss; hornblende gneiss, and pegmatite.

Almandite: (Dana, 1850, 656). *Tourmaline:* (Dana, l. c). *Muscovite:* (Dana, l. c.). *Laumontite:* (Dana, l. c.).

ROCKLAND, just north of Columbia Bridge.

Microline: cleavage masses (Groth, 1903, 167).

Hill west of P. & R. Junction R. R., north of drive going west from Columbia Bridge. Exposures in washout. Wissahickon gneiss and pegmatite.

Tourmaline: crystals (Benge and Wherry, XII, 1905, 119).

Quarry and bluff, south side of Lansdowne Ravine, facing P. & R. Ry. Quarry is abandoned; the best specimens were found in the top soil. Wissahickon gneiss and pegmatite.

Quartz: smoky (Benge and Wherry, XII, 1905, 119). *Microcline:* pink crystals measuring 12 × 25 cm. (Groth, 1903, 168). *Albite:* (Benge and Wherry, l. c.). *Oligoclase:* (Benge and Wherry, l. c.). *Beryl:* altered crystals (Groth, 1903, 168). *Almandite:* rough crystals measuring 5 cm. (Groth, 1903, 169). *Tourmaline:* black (Groth, 1903, 169). *Muscovite:* (Groth, 1903, 168). *Biotite:* in muscovite (Benge and Wherry, l. c.). *Ilmenite:* black crystals (Benge and Wherry, XIII, 1906, 93).

Exposures across the railroad from the above. *Laumontite:* crystals (Benge and Wherry, XIII, 1906, 93).

Bluffs along West River Drive, above Girard Avenue Bridge. Wissahickon gneiss and pegmatite.

Quartz: colorless; *amethyst:* (Groth, 1903, 169; Benge and Wherry, XIII, 1906, 93). *Microcline:* (Benge and Wherry, l. c.). *Albite:* (Groth, 1903, 169). *Beryl:* (Groth, 1903, 169). *Almandite:* massive (Groth, 1903, 169). *Epidote:* crystals (Groth, 1903, 169); *Tourmaline:* black (Benge and Wherry, l. c.). *Ilvaite?* (Benge and Wherry, XIII, 1906, 93). *Muscovite:* (Rand, 1867, 276). *Biotite:* rough crystals; enclosed in muscovite (Rand, 1867, 276; Senarmont, 1852, 171). *Titanite:* yellow and brown (Groth, 1903, 169). *Stilbite:* (Groth, 1903, 169). *Chabazite:* red (Groth, l. c.). *Heulandite:* (Groth, l. c.). *Natrolite:* (Groth, l. c.). *Apatite:* green (Groth, 1903, 170). *Calcite:* rhombohedra (Groth, 1903, 169). *Pyrite:* (Benge and Wherry, XII, 1905, 119). *Hematite:* crystals (Groth, 1903, 169). *Ilmenite:* rough crystals were also found in a quarry on the south side of Girard Ave., between 38th and 39th Street (Rand, 1892, 176; Benge and Wherry, XII, 1905, 119). *Autunite:* yellow crystalline scales (Groth, 1903, 169). *Wad:* coatings on the gravels overlying the schists (Rand, 1867, 276).

EAST RIVER DRIVE TUNNEL, above Girard Avenue Bridge. The minerals reported were found in tunneling the hill, cutting the road, and in excavations on the hill above the tunnel. Wissahickon gneiss and pegmatite.

Microcline: crystals (Benge and Wherry, XII, 1905, 141). *Beryl:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, XIII, 1906, 93). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* crystals (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Ilmenite:* fine black tabular crystals, often curved, (Taylor, 1858, 175; Ford, 1882, 40). *Zircon:* (Benge and Wherry, XIII, 1906, 193).

Exposures along the East River Drive. Wissahickon gneiss and pegmatite.

Spessartite: dark reddish-brown trapezohedra measuring 3 cm. (Robinson, 1887, 251, analyses).

TURTLE ROCK.[233] East River Drive, above Boat House Row, at the base of Lemon Hill Wissahickon gneiss; hornblende gneiss, and pegmatite.

Hornblende: (Rand, 1892, 176). *Sillimanite:* (Rand, 1867, 276; 1892, 176). *Chabazite:* red (Rand, 1867, 276). *Laumontite:* (Benge and Wherry, XII, 1905, 141). *Apatite:* (Rand, 1867, 276). *Ilmenite:* (Rand, 1867, 276).

Rock exposures at the east end of Spring Garden Street Bridge. Pegmatite.

Tourmaline: black crystals (Lea, 1818, 473).

Bluffs on the west side of the Schuylkill River, north of Spring Garden Street Bridge, opposite the old Fairmount Water Works.[234] Wissahickon gneiss and pegmatite.

Quartz: colorless (Lea, 1818, 470); rose: (Benge and Wherry, XII, 1905, 120). *Microcline:* crystals (Lea, 1818, 475; Rand, 1871, 300). *Albite:* (Rand, 1892, 175). *Almandite:* (Rand, 1892, 176). *Beryl:* yellow and green, sometimes altered (Lea, 1818, 472; Dana, 1868, 780; Genth, 1875, 71). *Epidote:* (Lea, 1818, 470). *Tourmaline:* black (Seybert, 1808, 159; Lea, 1818, 472). *Muscovite:* smoky brown (Silliman, 1850, 377). *Biotite:* (Rand, 1892, 176). *Bismuthinite:* in tourmaline (Genth, 1875, 9). *Molybdenite:* (Genth, 1875, 9). *Pyrite:* (Benge and Wherry, XII, 1905, 120). *Chalcopyrite:* (Rand, 1892, 176). *Ilmenite:* black rhombohedral crystals (Dana, 1868, 780; Genth, 1875, 36). *Uraninite:* (Wherry, 1908, 68; Brown).

Weathering products: *Malachite:* (Rand, 1892, 176). *Kaolinite:* (Rand, 1892, 175). *Gummite:* (Benge and Wherry, XII, 1905, 120). *Autunite:* yellow crystalline plates (Dana, 1854, 491; Rand, Proc. Acad. Nat. Sci. Phila., 7, 1855, 286; Lewis, 1882, 49). *Torbernite:* green scales (Rand, 1867, 276; Wherry, 1908, 68). *Uraconite:* (Rand, 1892, 176). *Hyalite:* (Rand, 1892, 176). *Wad; asbolite:* (Rand, 1892, 276).

Old quarry and P. R. R. cut near 36th Street. Wissahickon gneiss and pegmatite.

Almandite: brilliant red crystals (Rand, 1892, 177). *Wad, asbolite:* (Dana, 1892, 1070).

GEORGE'S HILL. Cut on Park Trolley Line, west of 52nd Street Station; exposure of quarry on P. & R. Ry. opposite George's Hill. Wissahickon gneiss; hornblende gneiss; and pegmatite.

Hornblende: radiated (Benge and Wherry, XII, 1905, 120). *Almandite:* (Groth, 1903, 170). *Epidote:* crystals (Benge and Wherry, XII, 1905, 120, XIII, 1906, 93). *Zoisite, thulite:* crystals (Groth, l. c.; Benge and Wherry, l. c.). *Sillimanite:* (Rand, 1892, 177; Groth, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *"Aquacreptite:"* (Benge and Wherry, l. c.). *Chalcopyrite* (Rand, 1892, 177). *Malachite:* (Rand, l. c.). *Chrysocolla:* (Rand, l. c.). *Wad, asbolite:* (Benge and Wherry, l. c.).

WEST PHILADELPHIA

Street improvements at 48th St. and Fairmount Avenue. Inaccessible. Wissahickon gneiss and pegmatite.

Quartz: smoky crystals (Benge and Wherry, XIII, 1906, 93). *Microcline:* (Benge and Wherry, XII, 1905, 120). *Hornblende:* (Benge and Wherry, XII, 1905, 120). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Kaolinite:* (Benge and Wherry, l. c.). *Wad:* (Benge and Wherry, l. c.).

Haverford Avenue and 51st Street.

Tourmaline: (Benge and Wherry, XII, 1905, 121).

KINGSESSING QUARRY, 45th and Walnut Streets. Abandoned. Wissahickon gneiss and pegmatite.

Quartz: (Benge and Wherry, XII, 1905, 121). *Almandite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Sillimanite:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *"Aquacreptite:"* (Benge and Wherry, l. c.).

[233] Turtle Rock was a rounded rock exposed in the Schuylkill River at low tide, before the Fairmount dam was built.

[234] A number of quarries occupied this site. The largest, immediately on the river bank, was known as Judge Peter's quarry. Other quarries were opened on the other side of the railroad and to the southeast. When the inclined plane was abandoned, the P. R. R. made a curved cut through the rocks extending from 30th Street to 34th Street, and a series of quarries was opened. Subsequently the bluff between the railroad and the river was quarried away. The entire area is now occupied by the P. R. R. (Rand, 1867; 1892).

Quarry at 44th St. and Baltimore Ave. Inaccessible. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XII, 1905, 121). *Oligoclase:* (Benge and Wherry, l. c.). *Muscovite:* enclosing plates of biotite (Hall, 1881, 131; Lewis, 1882, 311). *Biotite:* imperfect brownish-black crystals, sometimes interfoliated with muscovite (Hall, 1881, 131; analyses; Lewis, 1882, 311). *Apatite:* (Benge and Wherry, l. c.).

Quarry at 42nd Street and Woodland Ave. and exposures across creek, about 45th St. Abandoned. Wissahickon gneiss; pegmatite.

Albite: (Rand, 1867, 272). *Muscovite:* crystals (Benge and Wherry, XII, 1905, 121). *Biotite:* (Benge and Wherry, l. c.). *"Aquacreptite:"* (Benge and Wherry, l. c.). *Apatite:* (Rand, l. c.).

Exposures along the west side of Schulkill River, near Gray's Ferry Bridge. Wissahickon gneiss and pegmatite.

Microcline: (Benge and Wherry, XII, 1905, 121). *Albite:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Vermiculite:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.).

Quarry at 50th Street and Elmwood Ave. Abandoned. Wissahickon gneiss and pegmatite.

Ilmenite: crystals (Benge and Wherry, XIII, 1906, 93).

P. B. & W. R. R. cut, ½ mile southwest of Gray's Ferry Road. Wissahickon gneiss.

Mirabilite:[235] white efflorescence (Rand, 1871, 304; 1892, 175; Genth, 1875, 148).

Elmwood Ave. between 58th and 60th Streets. River gravels.

Quartz: blue, and rose; agate (Benge and Wherry, XII, 1905, 121). Blue quartz also occurs at Gibson's Point.

Schuylkill River sands and gravels.

Ilmenite: (Genth, 1875, 36). *Zircon:* minute colorless crystals (Genth, 1875, 77). *Flint; jasper:* (Genth, 1875, 60).

Hestonville

Quarry at 59th Street and P. R. R. Hestonville. Wissahickon gneiss.

Orthoclase: crystals (Genth, 1875, 93). *Sillimanite:* (Benge and Wherry, XII, 1905, 139). *Pyrite:* (Rand, 1892, 177).

Weathering products: *Alunogen:* small silky fibrous coatings, especially developed during dry summer weather (Rand, 1867, 175). *Halotrichite:* yellowish-white, silky fibrous masses (Genth, 1875, 150). *Glockerite:* brownish, resinous, stalactitic (Genth, 1875, 151).

Overbrook. Exposures on 67th St., between Woodbine and Malvern Avenues, about 1/4 mile west of the Pennsylvania Blind Asylum. Wissahickon gneiss and pegmatite.

Quartz: limpid and smoky crystals up to 30 cm. in length (Lewis, 1905, 69; 1906, 111; Benge and Wherry, XII, 1905, 139). *Microcline:* (Benge and Wherry, l. c.). *Hornblende:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Rutile:* minute brilliant transparent ruby-red crystals on quartz (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Limonite* pseudo. *pyrite:* (Benge and Wherry, l. c.). *"Aquacreptite:"* (Benge and Wherry, l. c.).

Campbell's Quarry, on the west side of East branch of Indian Creek, ½ mile north of Lansdowne Ave. Wissahickon gneiss and pegmatite.

Quartz: crystals (Benge and Wherry, XIII, 1906, 93). *Microcline:* (Benge and Wherry, l. c.). *Hornblende:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Epidote:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Beryl:* crystals (Benge and Wherry, XV, 1908, 108). *Muscovite:* (Benge and Wherry, XIII, 1906, 93). *Chlorite:* (Benge and Wherry, XIII, 1906, 93). *Titanite:* (Benge and Wherry, l. c.). *Calcite:* (Benge and Wherry, l. c.).

Quarry on the east side of the west branch of Indian Creek, just below Great Rock Dam. Idle. Wissahickon gneiss and pegmatite.

Beryl: crystals (Benge and Wherry, XIII, 1906, 93). *Tourmaline:* (Benge and Wherry l. c.).

Exposures on the west side of the west branch of Indian Creek, below Great Rock Dam Wissahickon gneiss and pegmatite.

[235] Called glauberite by Genth.

Quartz: crystals (Benge and Wherry, XIII, 1906, 93). *Limonite:* (Benge and Wherry, l. c.). *Wad:* (Benge and Wherry, l. c.).

LANSDOWNE AVENUE and 64th Street. Grading of hill and street cuts. Wissahickon gneiss.

Orthoclase: porphyritic crystals showing carlsbad twinning (Gordon: Am. Min., 2, 110, 1917). *Hyalite:* coatings on gneiss.

Quarry, Lansdowne Ave. and 66th Street. Wissahickon gneiss and pegmatite.

Orthoclase: (Benge and Wherry, XII, 1905, 139). *Muscovite:* (Benge and Wherry, l. c.). *"Aquacreptite:"* (Eyerman, 1889, 37).

MULLIN'S QUARRY, 65th and Callowhill Streets. Wissahickon gneiss and pegmatite.

Quartz: crystals (Benge and Wherry, XII, 1905, 140). *Orthoclase:* (Benge and Wherry, l. c.). *Hornblende:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.).

PERNA'S QUARRY, 66th and Vine Streets. Wissahickon gneiss and pegmatite.

Orthoclase: (Benge and Wherry, XII, 1905, 140). *Hornblende:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Titanite:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.).

COBB'S CREEK VALLEY

Exposures along Cobb's Creek, about 1/8 mile south of 63rd and Market Sts. Wissahickon gneiss.

Sillimanite: (Benge and Wherry, XII, 1905, 140).

BALTIMORE AVE. between 52nd and 60th Sts. Sewer excavations. Inaccessible. Pegmatite.

Tourmaline: (Benge and Wherry, XII, 1905, 140). *Quartz:* crystals on 58th St. below Baltimore Ave., in a sewer excavation (Benge and Wherry, l. c.).

BILLINGER'S QUARRY, Church Lane and Cobb's Creek, about 70th Street. Wissahickon gneiss and pegmatite.

Quartz: etched crystals (Benge and Wherry, XII, 1905, 140). *Orthoclase:* (Benge and Wherry, XIII, 1906, 93). *Almandite:* (Benge and Wherry, XII, 1905, 140). *Grossularite:* (Benge and Wherry, XII, 1905, 140). *Beryl:* (Benge and Wherry, XII, 1905, 140). *Sillimanite:* (Benge and Wherry, XIII, 1906, 93). *Muscovite:* (Benge and Wherry, XIII, 1906, 93). *Biotite:* (Benge and Wherry, XIII, 1906, 93). *Calcite:* crystals (Benge and Wherry, XII, 1905, 140). *Fluorite:* (Benge and Wherry, XII, 1905, 140). *Limonite* pseudo. *pyrite:* (Benge and Wherry, XII, 1905, 140). *Hyalite:* (Benge and Wherry, XII, 1905, 140; XIII, 1906, 93).

WINNEFIELD QUARRY, Winnefield and Bryn Mawr Avenues. Wissahickon gneiss.

Microcline: (Benge and Wherry, XII, 1905, 160). *Hornblende:* (Benge and Wherry, l. c.). *Almandite:* (Benge and Wherry, l. c.). *Tourmaline:* (Benge and Wherry, l. c.). *Muscovite:* (Benge and Wherry, l. c.). *Biotite:* (Benge and Wherry, l. c.). *Apatite:* (Benge and Wherry, l. c.).

CENTRAL PHILADELPHIA[236]

PENNSYLVANIA AVENUE, between 21st and 28th Streets. Excavations for the P. & R. Ry. Inaccessible. Wissahickon gneiss and pegmatite.

Quartz: rose: (Benge and Wherry, XII, 1905, 141). *Microcline:* crystals (Groth, 1903, 166). *Hornblende:* (Benge and Wherry, l. c.). *Beryl:* (Benge and Wherry, l. c.). *Almandite:* (Groth, l. c.). *Tourmaline:* (Groth, l. c.). *Muscovite:* (Groth, l. c.). *Biotite:* (Groth, l. c.). *Kaolinite:* (Groth, l. c.). *Apatite:* (Benge and Wherry, l. c.). *Pyrite:* (Benge and Wherry, l. c.). *Chalcopyrite:* (Benge and Wherry, l. c.). *Molybdenite:* (Groth, l. c.).

MARKET AND 11TH STREETS.

Gold: disseminated in the clays; found in digging a cellar (Dubois and Eckfeldt, 1861, 275).

Cellar of a house at 106 Arch Street. River gravels.

Quartz: (Genth. Am. Phil. Soc., 11, 439, 1870). *Almandite:* (Genth, l. c.). *Ilmenite:* (Genth, l. c.). *Zircon:* (Genth, l. c.).

[236] The following old reports were made by Browne (1831, 518): "Mill Dam, upon old Fourth Street:" beryl and muscovite, "State Penitentiary, Coates Street:" beryl, wernerite, apatite.

PIKE COUNTY[227]

BUSHKILL.

Fluorite: in quarries near Bushkill (Genth, 1875, 29).

POND EDDY.

Quartz: slender crystals near Pond Eddy, Shohola township (I. C. White, Sec. Geol. Surv. Penna. Rep., G6, 1882, 190).

GUYMARD.

Sphalerite: in veins in Oneida conglomerate (White, l. c., page 151). *Galena:* (White, l. c.).

POXONO ISLAND.

Sphalerite: in Catskill sandstone (White, l. c., page 217). *Malachite:* green stains (White, l. c.).

SCHUYLKILL COUNTY[228]

MAHANOY CITY. Coal mines in valley northeast of Mahanoy City. Carboniferous sedimentary rocks.

Quartz: crystals (Taylor, 1858, 175). *Pyrophyllite:* white to yellowish-white, pearly seams in coal (Taylor, l. c.; Genth, 1879, 279). *Alunogen;* white efflorescence (Reinhold, 1882, 55). *Copiapite:* yellow masses (Reinhold, 1882, 60).

TAMAQUA.

Kaolinite; pholerite: white and yellowish-white, pearly scales (Genth, 1859, 251, analysis; Johnson and Blake, 1867, 354). Also occurs as leathery or raglike coatings on quartz in coal mines on the Mahanoy R. R. (Genth, 1875, 118).

POTTSVILLE.

Kaolinite; pholerite: snow-white, pearly plates (Genth, 1859, 251, analysis). *Siderite:* small rhombohedral crystals with kaolinite and quartz (Genth, 1875, 160). *Galena:* in carboniferous sandstone (Genth, 1875, 11), *Pyrite:* with galena (Genth, 1875, 11).

SWATARA.

Quartz: doubly terminated crystals measuring 3 cm. in the Marshall coal tract, 3 miles west of Swatara (Genth, 1876, 218).

SHAMOKIN.

Quartz: colorless crystals in coal mines (Genth, 1875, 56).

SULLIVAN COUNTY

MUNCY VALLEY.

Chalcocite: in the Catskill red sandstone (Genth, 1875, 16). *Bornite:* (Genth, 1875, 13).

FORKVILLE.

Galena: in limestone at the Millview quarry (Eyerman, 1889, 4).

SUSQUEHANNA COUNTY

GREAT BEND.

Wad: in Catskill sandstone (Eyerman, 1889, 12).

TIOGA COUNTY

Quartz: crystals (Seybert, 1808, 153).

WARREN COUNTY

Melanite: at Warren (Genth, 1875, 75).

[227] Wad has been reported from Westfall township (Eyerman, 1889, 12).

[228] Kunz (1890, 198) lists pyrite crystals from the Raven Run mine, 6 miles from Mahanoy City. Genth (1876, 218), reports large quartz crystals from "Heckel's Forge."

WESTMORELAND COUNTY

GREENSBURG.

Silicified wood: fossil trees, 7 miles east of Greensburg (Proc. Acad. Nat. Sci. Phila., 1854, 64).

IRWIN.

Pyrite: stalactitic in the Westmoreland Coal Co. mines (Genth, 1875, 20).

SALTSBURG.

Epsomite: fibrous crystals with coal on the Kiskiminetas River (M. H. Boyé, Proc. Am. Phil. Soc., IV, 247, 1847).

WYOMING COUNTY

Malachite: in Catskill sandstone in Nicholson township (Eyerman, 1889, 45).

YORK COUNTY[239]

CARROLL TOWNSHIP

DILLSBURG. Magnetite mines east of Dillsburg. Triassic shales; intrusive diabase; hydrothermal deposits of magnetite.

Magnetite: (Spencer, 1908, 74–96). *Pyrite:* (Spencer, l. c.). *Andradite:* brown (Genth, 1876, 220).

FRANKLIN TOWNSHIP

FRANKLINTOWN.

Melaconite: in Triassic shales (Eyerman, 1889, 8, 34). *Malachite:* (Eyerman, l. c.).

HELLAM TOWNSHIP

WRIGHTSVILLE. Beards quarry, northern Wrightsville. Cambro-ordovician limestone.

Calcite, Dolomite, Quartz, Fluorite, Pyrite, Chalcopyrite, Hematite: (Jandorf, 1912, 89). Fields and roadsides at Wrightsville.

Limonite pseudo. *pyrite:* large cubes (Wherry).

HELLAM. Limestone quarries near Hellam: Emig's quarry, on Creitz Creek, 1 mile S. E. of Hellam; Stoner's quarry along P. R. R., $1\frac{1}{4}$ miles S. W. of Hellam; and the York Valley Lime Co. quarry, on the York turnpike, $1\frac{1}{4}$ miles west of Hellam. Cambro-ordovician limestone.

Calcite, Dolomite, Quartz, Fluorite, Apatite, Graphite, Pyrite, Chalcopyrite, Galena, Sphalerite, Hematite, Chlorite: (Jandorf, 1912, 90–93).

JACKSON TOWNSHIP

SPRING GROVE. Alwine's quarry, on the P. R. R., about ½ mile west of Spring Grove. Cambro-ordovician limestone.

Calcite, Dolomite, Quartz, Fluorite, Serpentine, Pyrite, Chalcopyrite, Gypsum: (Jandorf, 1912, 101).

LOWER WINDSOR TOWNSHIP

MARGARETTE FURNACE. Ore banks southeast of, and 2 miles N. W. of Margaretta Furnace. Cambro-ordovician limestone, etc; residual deposits of goethite and limonite.

Goethite: (Frazer, 1876, 20). *Turgite:* (Frazer, l. c.). *Limonite:* (Frazer, l. c.).

MANCHESTER TOWNSHIP

NEW HOLLAND. Union Stone Co. quarry, $\frac{3}{8}$ mile north of New Holland. Cambro-ordovician limestone.

[239] In an early list, Clemson (1834, 163) reported the following minerals from "York County:" quartz, collophanite, epidote, wavellite, halloysite, talc, magnetite, hematite, cuprite, malachite, chalcopyrite, gold, and galena. Genth (1875, 58) listed quartz, variety cats-eye, with inclusions of actinolite. Piedmontite (probably epidote) was listed by Cleaveland (1816, 300). The Shrewsbury meteorite was found near Shrewsbury, in the township of that name (Farrington, 1910, 350).

Calcite, Dolomite, Ankerite, Siderite, Aragonite, Quartz, Fluorite, Graphite, Pyrite, Chalcopyrite, Sphalerite, Hematite: (Jandorf, 1912, 97).

EMIGSVILLE. Limestone quarry, 1/4 mile west of Emigsville. Cambro-ordovician limestone.

Calcite, Dolomite, Quartz, Fluorite, Asbestus, Talc, Pyrite, Chalcopyrite, Sphalerite: (Jandorf, 1912, 96).

NEWBERRY TOWNSHIP

YORK HAVEN.

Augite: (Ehrenfeld, 1893, 5; analysis). *Stilbite:* white, radiating (Ehrenfeld, 1890, 157; 1893, 4; analyses). *Chabazite:* (Ehrenfeld, 1893, 4).

NORTH CODORUS TOWNSHIP

NEW SALEM.

Amethyst: (Genth, 1875, 57). *Hematite:* micaceous, black and red (Genth, 1875, 34).

PEACHBOTTOM TOWNSHIP[240]

Slate quarries near Peachbottom, on the Susquehanna River.

Wavellite: small spherical and radiating, grayish-white aggregates (Dana, 1850, 656; Genth, 1875, 142).

PENN TOWNSHIP

HANOVER.

Quartz: smoky crystals (Seybert, 1808, 155). *Calcite:* crystals in geodes, near Seitzville Station, about 1 1/4 miles from Hanover Junction (Frazer, 1876, 98).

SPRING GARDEN TOWNSHIP

YORK. Limestone quarries near York: Schum and Ruhl's quarry, north of P. R. R. 1 1/2 miles northeast of York. Ebert and Hake's quarry, south of P. R. R., 1 1/4 miles east of York; and west of Chanceford Pike, 5/8 mile S. E. of York. Cambro-ordovician limestone.

Calcite: rhombohedra, (Ebrenfeld, 1890, 281). *Dolomite:* (Jandorf, l. c.). *Ankerite:* (Jandorf, l. c.). *Siderite:* (Jandorf, l. c.). *Quartz:* (Jandorf, l. c.). *Fluorite:* purple (Ehrenfeld, 1890, 281, analysis). *Nitrocalcite:* (Jandorf, l. c.). *Pyrite:* (Jandorf, l. c.). *Chalcopyrite:* (Jandorf, l. c.). *Hematite:* (Jandorf, l. c.). *Malachite:* (Jandorf, l. c.). *Sphalerite:* light yellow (Ehrenfeld, 1890, 281; 1893, 5).

SCHUMP'S HILL. One mile south of York. Cambrian quartzite, slaty schists, and limestone.

Limonite pseudo. *pyrite:* found in the soil, especially along the road running east and west, south of the hill. Crystals occur up to 15 cm., but usually from 3 to 10 cm. in diameter (Holden, 1919, 68). Also occur at Webb's Hill, 3 1/2 miles from York (Shettel, 1887, 7).

WARRINGTON TOWNSHIP[241]

Tourmaline: at Rossville (Eyerman, 1889, 26). *Malachite:* at Atland's mine, 2 1/2 miles southwest of Wellsville (Eyerman, 1889, 45).

WEST MANCHESTER TOWNSHIP

YORK VALLEY. Limestone quarries west of York: Burgard's quarry, on a stream, 1 1/4 miles N. W. of York; York Stone and Supply Co. quarry, 1/4 mile west of Burgard's quarry; three quarries near P. R. R. 2 miles west of York. Cambro-ordovician limestone.

Calcite, Dolomite, Quartz, Fluorite, Barite, Serpentine, Talc, Pyrite, Chalcopyrite, Galena, Sphalerite, Malachite, Gypsum, Nitrocalcite: (Jandorf, 1912, 95, 98, 101).

[240] The following indefinite reports have been made: Rutile: between Essex Hall and the State Line (Rogers, 1858, I, 192). Actinolite, asbestus, serpentine, chlorite, ilmenite, and magnetite in a ridge of serpentine, 5 miles west of the Susquehanna River (Seybert, 1808, 267; Rogers, 1858, I, 172).

[241] Quartz, asbestus, and prasilite have been reported from "near Harman's blacksmith shop, 6 miles southeast of Dillsburg" (Genth, 1876, 218; Frazer, 1876, 114).

THOMASVILLE. Quarry, 1/4 mile south of Thomasville. Cambro-ordovician limestone. *Calcite, Dolomite, Quartz, Pyrite:* (Jandorf, 1912, 100).

YORK TOWNSHIP

ORE VALLEY.

Goethite: stalactitic, fibrous masses (Frazer, 1876, 24). *Lepidocrocite:* (Frazer, l. c.) *Turgite:* (Frazer, l. c.). *Limonite:* (Frazer, l. c.).

DALLASTOWN.

Siderite: gray, massive (Genth, 1876, 228).

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INDEX

Actinolite 82
Adularia 72
Agate 47
Albite 74
Allanite 95
Allophane 127
Almandite 86
Alunogen 147
Amazonstone 73
Amethyst 47
Amphibole group 81
Analcite 105
Andalusite 90
Andradite 87
Anglesite 142
Anhydrite 145
Ankerite 63
Anorthite 77
Anthophyllite 81
Antigorite 121
Apatite 133
Apophyllite 99
Aquacreptite 125
Aragonite 65
Argentine 61
Arsenopyrite 44
Asbestus 82, 122
Asparagus-stone 133
Augite 79
Aurichalcite 68
Autunite 139
Aventurine 47
Avondale, Chester Co. 171
Avondale, Delaware Co. 193, 195 197
Axinite 96
Azurite 67

Baltimorite 121
Bamford 203
Barite 141
Basanite 47
Beartown 202
Bellwood 160
Beraunite 138
Beryl 84
Bieberite 146
Bindheimite 140
Biotite 108
Birdsboro 158
Bismuth 35
Bismuthinite 36
Bismutite 71
Blende 37
Blue Hill 199
Boothwyn 197
Bornite 40
Botryogen 148
Bournonite 45
Bowenite 121
Brandywine Summit 185
Braunite 53
Breunnerite 63
Bridgeport 217
Brinton's quarries 182
Brochantite 145
Bronzite 78
Brookite 54
Brucite 57
Byssolite 83

Cacoxenite 138
Calamine 97
Calcite 61
Campbell's Hump 220
Carnelian 47
Carnotite 139
Cassinite 72
Castle Rock 188
Celestite 142
Cerolite 126
Ceruleolactite 138
Cerussite 66
Chabazite 102
Chalcanthite 146
Chalcedony 47
Chalcocite 37
Chalcodite 116
Chalcopyrite 40
Chelsea 185
Chert 47
Chester 186
Chesterlite 73
Chestnut Hill 219, 223
Chlorite group 112
Chloritic vermiculites 112, 117
Chloritoid 111
Chloropal 128
Chondrodite 97
Chromite 52
Chrysocolla 128
Chrysoprase 47
Chrysotile 122
Citrine 47
Clinochlore 112
Colerainite 125
Columbite 130
Conshohocken 215
Copesville 167
Copiapite 147
Copper 35
Cornwall 207
Corundellite 111
Corundum 50
Corundum Hill 173
Covellite 39
Credneriite 53
Crocidolite 84
Cuprite 49
Cyanite 92

Damourite 105
Datolite 92
Delawarite 72
Descloizite 135
Deweylite 123
Diallage 79
Diaspore 55
Diopside 79
Dioptase 89
Dolomite 62

Easton 219
Eastonite 119
Ecton mine 214
Emerylite 111
Enstatite 78
Epidesmine 101
Epidote 94
Epsomite 145
Erythrite 136
Euphyllite 108
Euxenite 131

Fairmount Park 231
Falunite 108
Fayalite 89
Feldspar group 71
Fergusonite 130
Finney's quarry 164
Fleetwood 157
Flint 47
Flint Hill 157
Fluorite 45
Frankford 228
French Creek mines 178
Friedensville 210
Fritz Island 153
Fruitville 206
Fuchsite 105

Gadolinite 92
Gahnite 52
Galena 37
Gap nickel mines 202
Garnet group 85
Genthite 124
Germantown 225
Gersdorffite 44
Gibbsite 57
Gickerville 158
Gismondite 103
Glauberite 141
Glockerite 147
Goethite 55
Gold 35
Goslarite 146
Graphite 34
Greenockite 39
Grossularite 85
Gummite 140
Gypsum 145

Hallite 117
Halloysite 126
Halotrichite 147
Hausmannite 53
Hellertown 220
Hematite 50
Henderson 217
Heulandite 101
Hisingerite 129
Hopewell mines 178
Hornblende 83
Hornstone 47
Hydrocuprite 49
Hydromagnesite 69
Hydrozincite 67
Hypersthene 78

Ilmenite 51
Ilvaite 97

Jasper 47
Jefferisite 120
Jones mine 152

Kalinite 146
Kammererite 114, 115
Kaolinite 126
Kotschubeite 114

Labradorite 77
Lafayette 213, 221
Lancasterite 69
Langite 147
Lansford 166
Lansfordite 69
Lanthanite 68
Laumontite 103
Leidyite 119
Leiper's quarry 197
Leiperville 195
Lenni 193
Lennilite 72, 117
Lepidocrocite 57
Lepidomelane 109
Lesleyite 105
Libethenite 135
Limonite 55, 59
Line Pit 204
Lithiophorite 60
Löllingite 44

Magnesite 63
Magnetite 52
Mahanoy City 236
Malachite 66
Marble Hall 218
Marcasite 44
Margarite 111
Marietta 203
Marmolite 121
Martite 50
Mauch Chunk 166
Melaconite 49
Melanosiderite 59
Melanterite 146
Menaccanite 15
Mendipite 46
Mesolite 104
Mica group 105
Microcline 73
Microlite 130
Millerite 39
Mimetite 134
Mineral Hill 191
Mirabilite 145
Molybdenite 36
Molybdite 149
Monazite 133

Moonstone 74
Moore's Mill 183
Morenosite 146
Morgan 184
Moro Phillip's mine 189
Moroxite 133
Morton 196
Mountain cork 82
Mountain leather 82
Muscovite 105

Natrolite 103
Necronite 72
Neolite 125
Nephrite 82
Nesquehoning 166
Nesquehonite 68
New Galena 163
Niter 140
Nitrocalcite 140
Nontronite 128

Octahedrite 54
Oligoclase 75
Olivine 88
Opal 49
Oreland 216
Orthite 95
Orthoclase 72

Painterite 117
Pattersonite 118
Pectolite 80
Penninite 114
Pennite 62
Pentlandite 38
Pequa mines 207
Perkiomen mine 213
Philadelphite 109
Phlogopite 110
Phoenixville 176
Pholerite 126
Picrolite 121
Piedmontite 94
Platinum 35
Poorhouse quarry 179
Porcellophite 122
Prase 47
Prehnite 97
Prochlorite 115
Pseudomalachite 135
Psilomelane 60
Pyrite 42
Pyrolusite 54
Pyromorphite 134
Pyrophyllite 127
Pyroxene group 77
Pyrrhotite 39

Quartz 47

Randite 71
Retinalite 122
Rhodochrome 115
Rhodochrosite 64
Rhodophyllite 115
Ripidolite 114
Rock crystal 47
Roseite 118
Roslyn 216
Rubellite 98
Rutile 53

Sal-ammoniac 45
Salite 79
Samarskite 131
Saponite 126
Scheelite 148
Schwenksville 212
Scolecite 104
Scorodite 136
Selenite 145
Sepiolite 125
Sericite 105
Serpentine 121
Shaw and Esrey's quarry 186
Shimersville 209
Siderite 64
Sillimanite 91
Silver 35
Smithsonite 65
Spessartite 87
Sphalerite 37
Sphene 129
Spinel 51
Staurolite 99
Steatite 124
Stibnite 36
Stilbite 100
Stolzite 148
Strengite 136
Strontianite 65
Sulfur 34
Sunstone 75
Swarthmore 193, 197
Sylmar 181

Talc 124
Tennantite 45
Tetrahedrite 45
Texas 204
Thermophyllite 122
Thomsonite 105
Thulite 93
Tin 35
Titanite 129
Topaz 90
Torbernite 139
Tourmaline 98
Trainer 189
Tremolite 82
Trimble's mine 170
Turgite 56

Unionville 173
Uraconite 148
Uraninite 140
Uranophane 128
Uranotile 128
Uvarovite 88

Vanadinite 135
Vanartsdalen's quarry 164
Vauquelinite 145
Venerite 116
Vermiculites 112
Vesuvianite 89
Vivianite 136

Wad..... 60
Ward's quarry..... 195
Warwick mines..... 178
Wavellite..... 136
Wernerite..... 89
Wheatfield mines..... 159
Wheatley mines..... 176
Williamsite..... 121
Wissahickon Valley..... 223
Wollastonite..... 80
Wood's chrome mine..... 205
Wulfenite..... 148

Xanthocroite..... 39
Xenotime..... 133

Zaratite..... 71
Zeolite group..... 99
Zircon..... 90
Zoisite..... 93

3 2044 102 955 408